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ESSAYS AND ADDRESSES

BY

PROFESSORS AND LECTURERS

OF THE

Owens College, Manchester,

Published in Commemoration of the Opening of the new College Buildings, October 7th, 1873.

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PREFACE.

The College, with an important event in whose history the publication of this volume is intended to associate itself, was founded under the will of the late John Owens, of Manchester, merchant, in 1851. It was reconstituted and incorporated by Act of Parliament on September 1st, 1871; and its new buildings were formally opened on October 7th, 1873, by the Duke of Devonshire, K.G., the President of the College, whose kindness enables us to prefix to these Essays and Addresses the Opening Address delivered by His Grace on that occasion.

The authors of the contributions to this volume hold themselves individually responsible for the views and opinions severally advanced by them. But we are allowed to express a hope, on behalf of our colleagues as well as of ourselves, that this publication as a whole will be accepted in testimony of a feeling common to us all. It is designed to mark

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our recognition of the liberality with which the public of this city and district have made it possible to begin the work of the extension of our College, and of the single-minded and self-sacrificing exertions of friends and members of its Governing Body, whose devotion to its interests may, we trust, be rewarded by a future such as they desire for it.

B. S.

A. W. W.

April 9th, 1874.

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ERRATUM.

Page 177, line 2 from bottom, *for* "bodies" *read* "boilers."

[redacted]

PRESIDENT'S OPENING ADDRESS.

THE proceedings of the day having now commenced with a solemnity so entirely in harmony with the object which has brought us together, it devolves upon me to discharge the duty which has been assigned to me as President of the College of pronouncing officially the opening of this building. It has afforded me the very greatest satisfaction to be present here to-day to congratulate you on the completion of this noble pile of buildings, the foundation stone of which I had the honour of laying some three years ago. It has happened to most of us to be present at what is commonly called the inauguration of buildings intended for great public purposes. The custom of observing such occasions is one that commends itself to very general acceptance, and it is a custom for the observance of which, as it seems to me, very good reasons may be assigned. The success of any institution, as we know, depends in a very large measure on its local habitation and on its adaptation to the work that has to be carried on within it. Such buildings, moreover, embody the results of much time, much labour, much thought, and much money; and these considerations, as it seems to me, are amply

sufficient to account for the observance of the custom to which I have referred, at all events in the present instance; for amongst all the public buildings which adorn the streets of Manchester, or which minister to the various requirements of its vast population, there can be none of which we may more confidently anticipate that it will have an important influence on the future destinies of this great community, or will reflect greater credit upon the enlightened public spirit of Manchester and the district of which it is the centre than this. Owens College has now been somewhat more than 20 years in existence; but although its friends are entitled to view its present position with very great satisfaction, yet I am much mistaken if its further progress and developement are not greatly promoted and accelerated now that it comes into possession of the ample accommodation which this building provides. We may, therefore, I think, confidently anticipate that this day will form a most memorable epoch in the history of Owens College. The work which originated in the late Mr. Owens's munificent bequest was a work the magnitude of which has, perhaps, sometimes not been sufficiently appreciated. It was Mr. Owens's design to found a college in which instruction should be given in all the branches of knowledge which were taught at that time, or should thereafter be taught, in the English Universities. Mr. Owens's bequest, as the gift of a single individual, was unquestionably a very large and magnificent one; but still it was by no means sufficient for the full and entire accomplishment of so vast an undertaking as is included in the terms to which I have referred. In

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the interval which has elapsed since the foundation of Owens College the magnitude of the work to be carried on therein has become more apparent than would originally, perhaps, have been admitted. The range of studies at the old English Universities has been greatly extended, and it is now very generally recognised to be the proper function and duty of a university to teach not only some few selected subjects, but every great and important branch of human knowledge on which the human faculties can be employed. To provide, then, instruction co-extensive with this vast field was the duty committed to the Governing Body of Owens College, and anyone who reflects on the immense—the almost boundless—extent of that field must feel that the task was one which it was difficult to accomplish with an income, derived from endowments, of considerably under 4000*l.* a year; for, if I am not mistaken, that was the income which the Governors had at their disposal from Mr. Owens's original bequest, supplemented as it was by subsequent benefactions. To me it seems not a little remarkable that they have done so much, and that they should have raised the College to the position it now occupies, with means comparatively limited. I cannot but think it a fortunate circumstance that by the terms of Mr. Owens's bequest they were precluded from applying any portion of the money towards building purposes. Unless they had been so prohibited it is not improbable that the temptation to apply a portion of it in that way would have been irresistible, and the consequence not improbably would have been that at the present moment, instead of

being in possession of this spacious building, so well adapted for its purpose, you would have had a building of one-half the extent, and you would have had a teaching power of one-half the present strength. The whole undertaking in short would have been crippled and starved from the outset, and its success might have been indefinitely postponed. As it was, however, temporary accommodation was provided by the liberality of a gentleman, who, I believe, was either a friend or a connexion of Mr. Owens, and the Trustees were at once enabled to introduce a wide range of subjects into the College curriculum. None of the studies usually pursued at the Universities were omitted, although the amount of teaching power as regards many of them was altogether inadequate and incomplete. And here I must be allowed to express my admiration of the wise determination with which the objects of the College as defined by its founder have been steadily kept in view. It might possibly have been anticipated that in a place which owes so much to, and has become so celebrated as the seat of, manufacturing industry, and where pursuits of that kind are so deservedly held in honour,—it might have been anticipated that the older class of studies, those connected with literature, might have been pushed aside and comparatively disregarded. There might have been a danger that the application of science would have been regarded as of more importance than the imparting of a sound preliminary scientific instruction. But, on the contrary, we find that the importance of combining literary and scientific studies has been from the first recognised both in principle

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and in practice. The experimental sciences have been taught in their full depth and breadth, not in a fragmentary or superficial manner, with any supposed reference to their immediate application. Teaching of this high character is, in the opinion of those who are best qualified to form an opinion on the subject, essential not merely with reference to the interests of science itself, but with reference also to its application to manufacturing industry. The College has been fortunate in having from the beginning a staff of professors of very eminent ability, whose teaching has been of the highest order, and who have spared no pains or trouble or exertion to raise the character of the College, and to whom is especially due the position which it now occupies. One of the most striking proofs of the progress which the College has made is the great increase in the number of students, which amounted in the last session to upwards of one thousand. While, however, nothing can be more satisfactory than the view which presents itself to us, whether we regard the character of the teaching or the number of the students in the College, yet, on the other hand, its very success has only served to bring out more clearly the disadvantages under which it has hitherto laboured, and the removal of which has become essential to its further developement. As I have already said, I am far from regretting that no portion of its original funds was applied to building purposes; yet, as time went on, the question assumed a very different aspect; and when the existence of a great demand for high-class teaching in Manchester and its neighbourhood became fully established, it

became in every succeeding year a matter of more and more urgent importance that a building should be provided in which work of so much importance could be suitably carried on. Seldom, indeed, has there been a stronger case than that which the Trustees and Professors of Owens College some years ago laid before the public of Manchester and its neighbourhood. Fortunately, the appeal was addressed to those who were both able and willing to render their assistance in carrying out the great object for which it was invoked, and we see the result this day in the splendid building in which the work of the College will henceforth be carried on, and which has been provided, if I am not misinformed, at a cost considerably exceeding 100,000*l.*, and is pronounced by those who are to labour in it to be admirably adapted in all its arrangements for the purposes for which it is intended. Nor have the wants of the College in other respects been overlooked or neglected. Considerable additions have been made to the teaching staff, and the organisation of the College has been extended so as to embrace schools both of law and of medicine, objects which the Council have always regarded as of great importance, as tending materially to add to the university character of the College. The incorporation of the Manchester Royal School of Medicine, which, I am told, has always stood high among similar institutions, has most satisfactorily fulfilled the purpose of the Council as far as that branch of study is concerned; and there is every reason to believe that the medical teaching of Owens College, now that it forms an integral part of the academical system, will render

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increased service in promoting the developement of that great department of science. As other marks of the increasing strength of the College, as well as the confidence which is reposed in its administration, I may refer also to the acquisition of the Museum of Natural History and of Geology. As has been pointed out by the Principal of the College in a recent Report, this acquisition was of immense importance, inasmuch as an opportunity will now be afforded to the student of practical work in those sciences in which practical work is so essential to their successful prosecution. We may, therefore, regard the present organisation and position of the College with unmingled satisfaction. Still, however, I apprehend that although very much has been done, very much more remains to be done. I believe that the Council have already taken upon themselves responsibilities and liabilities which will involve a very considerable outlay. The work of the College is likely for many years to come, judging from experience, to be a growing work, and if only funds are provided there is an ample store of objects upon which they may be expended with great advantage. I may be allowed to remind the students of this College, and more particularly the Associates, that on them in a great measure depends the full accomplishment of those further objects. The prosperity of the College is, to a great extent, in their keeping. The establishment of this College has, in the case of many of them, provided them with a training which would otherwise have been wholly beyond their reach. They are, therefore, bound by the strongest motives to manifest and prove their

loyalty to the College to which they owe such inestimable advantages. Many of them, I am happy to say, have already distinguished themselves, and have shown in their subsequent careers how well they have profited by the training they received here. The more numerous such instances continue to be, and the more clearly the reputation of the College is established as providing a training which qualifies men to become valuable, and able, and influential members of the community, the more generally such is the case, the more we may confidently anticipate will the liberality and generosity of the people be stimulated to provide those additional funds which are still required in order that the College may be able to carry on in its entirety the great work in which it is engaged. I shall now conclude with performing the official duty which is entrusted to me, namely, of declaring this building open for the purposes for which it has been erected.

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I.

On some Relations of Culture to Practical Life.*

Τὸ μὲν οὖν λεκτικοὺς καὶ πρακτικοὺς καὶ μηχανικοὺς γίγνεσθαι τοὺς συνόντας οὐκ ἔσπευδεν, ἀλλὰ πρότερον τούτων ᾤετο χρῆναι σωφροσύνην αὐτοῖς ἐγγενέσθαι. XEN. *Mem. Socr.* IV. iii. 1.

(Χρὴ δὲ) ἐφ' ὅσον ἐνδέχεται ἀθανατίζειν καὶ πάντα ποιεῖν πρὸς τὸ ζῆν κατὰ τὸ κράτιστον τῶν ἐν αὐτῷ. ARIST. *Eth. Nic.* X. vii. 8.

In accordance with the arrangements made by the Council for the opening of the Session 1873–4, in which we enter on the occupation of the new home provided for us by the liberality of the public of this district, I address you, not on some special topic belonging to my own department of our academical work, but on certain general questions which bear on all studies alike, and which ought to have an interest for all thoughtful men.

If I seem to be raising principles which have been discussed over and over again, my excuse must be that in this, as in other matters which are not concerned with abstract speculative truth, but touch closely on the interests or the prejudices of actual life, it is, in fact, necessary again and again to answer objections and to remove difficulties which assume a new form for successive generations.

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* Principal's Address to the Students on the occasion of the Opening of the new College buildings, October 7th, 1873.

I need hardly say that I am not about to call your attention to any of those numerous questions which, however pressing and important for the politician, have to do only with the outside aspects of education. I am addressing the assembled students of the new year; and it is because I feel that you are even more concerned in the enquiry than are my colleagues and myself, that I ask you to consider some of the relations which subsist between Culture and Practical Life, not as matters of speculative interest, but as bearing closely on the aims and the temper with which you should take up the studies of this place.

This enquiry might take either of two directions, accordingly as we consider the debt due from society to the student, or the debt due from the student to society. It is not possible altogether to separate these enquiries; but it is of the latter that I propose to speak more especially this morning, not only because in addressing students, as in addressing other men, it is more wholesome to speak of their *obligations* than of their *claims*, but also because in this place, and on this day, there is little need to urge the duties of society to the student. It may well be, however, that—liberal as is the provision here and elsewhere made of the *material appliances* of education—yet in the vehement discussions raised on the corresponding *principles* theories are sometimes broached, and arguments put forth, which, even though sound in themselves, have the effect of error from the exclusive attention which they challenge, and the false perspective in which they are viewed. This evil is comparatively slight for the combatants in these discussions. If a new truth is

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established, or an old one defended, the mischief of the exaggeration passes with the occasion. But it is far otherwise for those who, like you and us, are not combatants, but engaged in the peaceful work of education as the business of our life. We sometimes suffer, as non-combatants often do, almost as much from friend as from foe. For us the normal principles of education, in their whole range and mutual bearings, are of infinitely greater weight than the special questions which fix attention at the moment; but our thoughts are in danger of being drawn away from these deeper truths, and our springs of action of being in that degree weakened or perverted.

An illustration of this position may be seen in the history of the vigorous and successful efforts which, within a few years, have been made in favour of the claims of the natural sciences to a leading place in the curriculum of study. Men of genius and public spirit have insisted on them with unanswerable arguments; and I shall not be suspected by those who happen to be cognisant of the part which Owens College has taken in this matter of any inclination to call these claims in question. I wish, however, to point out that arguments are used in their support of very unequal force; and that whilst the able leaders of the crusade have dwelt most on the stronger among them, their followers are wont to recur too frequently to the weaker, and by raising them into undue prominence to run the risk of inducing—not the general public only, but, which is in reality a more serious thing, of inducing you and us to hold pernicious views as to what education is and what are the appropriate motives for it.

Of these arguments the weightiest is, I will venture to affirm, the most seldom heard—I mean the assertion that the natural and experimental sciences have a *characteristic discipline* for the mind. This position may in this place be taken for granted; and it constitutes of itself an argument at once unanswerable and sufficient. But when we hear the further argument that the physical sciences should hold a prominent place in education because their promotion contributes to the material advancement of the country, or because to possess a knowledge of them will give the learner a greater command of money and what money brings, we are then offered motives of a very different order. As collateral motives they have their value, I admit,—for exaggeration on one side must not be met by exaggeration on the other—but a value subordinate to that of the former consideration. It is of course true that *all* good education, through whatever medium, tends to produce good and well-furnished citizens, and therefore promotes the general, including the material, well-being of a country; and that all good education tends to make men manly and self-reliant, and so to train their faculties as to enable them, among other things, to win with greater ease their share of material good. It is true, too, that in choosing the subjects of study regard should be paid, in due degree, to the destination of the future life. But when the secondary and by nature inferior aim takes the first rank, the fatal consequence follows that the higher good is not even sought in the second place. The greater may include the less, but not the less the greater.

Another instance of harm to the business of edu-

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cation from the passing controversies of the hour lies in the sudden developement of the system of competitive examinations. To discuss the merits of this system in itself is altogether beside my object. I wish to refer only to its oblique influence on teachers and pupils, or rather (for each of these themes would admit of long discussion) to its influence on the temper of the student. Can anything be more deplorable—if it were not deplorable it would be grotesque—than the change which this system threatens to bring about in the mutual relations of study and examinations? By the old theory, the *business* of education was, first, the discipline of the intellect by means of the arts and sciences as instruments, and, secondly, the storing of the mind with methodical knowledge gained in the process. Examinations were but the handmaids of the teaching, designed to test and measure the results of study, and to correct its methods; and if honours and more substantial rewards were conferred on those who took the foremost places, this was partly to stimulate the flagging, and enable the more promising wits to prolong their season of study, and partly that public or academic offices might be filled by the fittest occupants. Under the new theory, posts of public responsibility and honour are viewed as so much booty—*pretium victoribus*—of which each is entitled to what he can carry off "with his bow and his spear." Competitive examinations are the race-course or the battlefield, and the years of education but as the obscure and irksome drill or training; good not for itself or its proper results, but for the prizes it will bring. But assuredly trained talent has no *jus divinum* of its own,

apart from the services which it can, and therefore is bound to, render to the common good. We do not appoint strong men to carry burdens, swift men as messengers, and keen-sighted men as scouts, because strength of muscle, or swiftness of foot, or keenness of vision, is a sort of merit which deserves reward; and exactly the same holds good of intellectual gifts. They are needed by the State and the Exchange, in the Forum and in the Camp; society in all its ramifications needs them, and has a claim on them, for they are hers as much as ours. Now, however, men are almost tempted to think that the public service exists for the sake of the sharp-witted or the industrious, and not they for it. "La carrière ouverte aux talens," once the stirring motto of an indignant people, has become a circumlocutory and more decorous version of the frank maxim of Ancient Pistol—

> "The world's mine oyster,
> Which I with sword will open."

We shall hear a far different sentence if we appeal to "the first of those who know," to "Plato the wise and broad-browed Verulam;"—for the perversion of which I am speaking is not a thing of to-day. When Plato is sketching the fit education of the "Guardians" of his ideal State, he insists on the fitness of the several sciences for this end, not, indeed, without regard to their practical use, but chiefly as *discipline.* He claims arithmetic and geometry as indispensable "for the sake of the soul herself," and, admitting that "they have indirect effects which are not small," insists that "they shall be pursued in the spirit of a philosopher, and not

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of a shopkeeper." And when Glaucon approves the proposal that astronomy shall be added, inasmuch as "the observation of the seasons, and of months and years, is quite essential to husbandry and navigation, and not less essential to military tactics," "I am amused," says Socrates, "at your fear of the world, which makes you guard against the appearance of insisting upon useless studies." Bacon, too, though he may at first sight seem to differ, is substantially of the same mind. He declares that, among the errors which tend to corrupt the advancement of learning, "the greatest of all the rest is the mistaking or misplacing of the last or furthest end of knowledge, for men have entered into a desire of learning and knowledge sometimes upon a natural curiosity and inquisitive appetite; sometimes to entertain their minds with variety and delight; sometimes for ornament and reputation; and sometimes to enable them to victory of wit and contradiction; and most times for lucre and profession; and seldom sincerely to give a true account of their gift of reason to the benefit and use of men." And, after declaring that "this is that which will indeed dignify and exalt knowledge, if contemplation and action may be more nearly and straitly conjoined together than they have been;" he proceeds: "Howbeit, I do not mean, when I speak of use and action, that end before-mentioned of the applying of knowledge to lucre and profession: for I am not ignorant how much that diverteth and interrupteth the prosecution and advancement of knowledge."

We are now prepared to answer the question which I wish to propose: What were the conditions under

which for many centuries the theory of the higher education was this,—that to all who sought it a common culture was provided in the first instance, and that from this, as from a trunk, three or four types of special or professional training branched off; and to what influences is it due that, in the present day, many are found to advocate the abandonment of this principle in favour of a method by which, the common groundwork being reduced to the narrowest limits, the special training is made to begin with the first year of college life, or even at a still earlier date?

The answer to this question I have already indicated, viz., that, according to the older theory, "a complete and generous education," in the words of Milton, is "that which fits a man to perform justly, skilfully, and magnanimously, all the offices, both private and public, of peace and war;" while the other theory holds that the aims and interests of the individual are to be chiefly kept in view.

Now it is, no doubt, true that, as is sometimes urged, these rival theories may be so handled as in appearance to lead to the same result: but in appearance only. It is true that the highest developement of any community not only allows, but *requires*, that the best possible use should be made of each of its members; and it is not less true, if less obvious, that an enlightened selfishness might discover that, *in the long run*, it can serve itself best by serving others. But "enlightened selfishness" has been a great many centuries in learning, in this field as in others, how "to save by losing itself."

If, then, as of course no one will seriously question,

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the older theory be sound, it will not be safe to leave the course of study wholly to the caprice of individuals. The experience or the instinct of academic bodies has aimed at giving effect to this principle, by requiring that students aspiring to academic honours, and to those diplomas which are the passports to the so-called learned professions, should pursue a course of studies uniform, or nearly uniform, up to a certain defined point. In our day, when University training is no longer sought only by those who are about to enter the liberal professions, and when, too, the narrow list of these professions is from time to time receiving one and another sister, it is a main academic problem to show that the old principles ought still to be insisted on in their essence, and yet that modifications must be made in detail in order that they may be applied with safety. For the champions of these principles have sometimes erred themselves almost as widely as their opponents. They have not only forgotten or underrated the claims of the individual, but they have failed to see that new pursuits, if added to the list of liberal professions, and admitted to a share in academic treatment, must exact some changes in the common preliminary culture. It is when we have to meet the reluctance, the natural reluctance, of students of this new order to submit to the yoke of academic traditions, that we are brought face to face with the rival claims of society and the individual. I say the *rival* claims; in fact, however, they are not rivals, but complementary each of the other. I mean not only that each has its rights which must not be ignored, but that each is necessary to the perfect developement of the other:

that, unless due play is given to the special gifts and aspirations of its members, society cannot reach its highest form, and that, unless individual men remember that they exist for the sake of society at least as much as for themselves, they, too, will fall short of their proper standard, and will leave some of their noblest faculties wholly unused.

The history, both of races and of individuals, is full of instances of the ruin that follows when the equilibrium between these two *moments* of all sound civilization and of all healthy life is violently disturbed. It is easy to see, for instance, how the intense individuality of the Greek and especially of the Athenian nature, unchecked by a constraining sense of public duty, contributed to the great disasters of Grecian history, and in the end to the political downfall of the country. We see, also, how the graceful, but too facile, receptivity of their intellect and of their moral nature, unchecked by the controlling influence of deep principles and external bonds, ended in a pliability which made Greeks the scorn of their Roman masters.* Rome still more aptly illustrates the opposite error in the excessive and cruel subordination of the Roman to Rome, and the gradual petrifaction of the national mind and character. The equilibrium is, it is true, difficult to maintain; but some approach to it is the

* As in the 'Græculus esuriens' of Juvenal. This tendency was not confined to the degenerate Greeks of a later day: see the droll praise of the polypus, as a type of character, in an epic fragment (ap. Athen. vii. 317) quoted by Bergk, *Griech. Literaturgeschichte*, i. 31 :—

Πουλύποδός μοι τέκνον ἔχων νόον, Ἀμφίλοχ' ἥρως,
τοῖσιν ἐφαρμόζευ τῶν κεν κατὰ δῆμον ἵκηαι.

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first condition of civilisation. We see one of these forces utterly suppressed in the unwieldy and stupid despotisms of the East, and the other only dimly present in the lawless life of the barbarous tribes of Northern Europe. No one can doubt which of the two extremes is the nobler and more hopeful: yet the comparison of Greek and Roman civilisation shows us that stability cannot be combined with brilliancy, unless the two forces are present in nearly an equal measure.

But I use this comparison by way of illustration only. My chief concern is to apply the same principle to the culture of the individual. If this tendency to isolation and reckless self-will no longer shows itself, at least in our country, in regard to the material life, there are signs of it in the domain of intellectual culture; and the caution is needed that here, too, Society has demands upon us. She may not tyrannise over our minds, any more than she may make slaves of our bodies; but neither may the individual "do what he will with his own."

Such is the broad principle on which rests the defence of that theory of academic culture, which has obtained almost without exception in European Universities.* It is not meant, of course, that the details of the common groundwork must be the same at all times and under all circumstances. The *subject-matter*

* The *Lehr- und Lern-Freiheit* of the German Universities forms no exception to the principle. The common groundwork is in Germany secured in the gymnasia, and any considerable change in the character of the standard is deprecated by the most enlightened among German men of science.

of the studies selected is, in fact, of less importance than the *discipline* imparted. This only is essential—that there should be such a selection made as will (1) draw out and strengthen the several powers of the mind, and (2) afford a basis so broad that on it may afterwards be erected the structure of professional study when the career is chosen. These conditions are met if the common groundwork includes (1) *Letters*, to cultivate the taste and judgement, to give a good style in speech or writing, and to place the student on the threshold of the best literature of home or foreign growth;* (2) *Mathematics*, to discipline the reasoning faculty, to give the habit of concentrated thought, and to place in the student's hand a weapon indispensable for the thorough mastery of the physical sciences; and (3) some branch of *physical study*, to develope the powers of observation and inductive reasoning, and to impart the *method* of this study, so that, should the student afterwards take up a profession based on some physical science, as medicine, engineering, or manufacturing art, he may be able with facility and pleasure to provide himself with the technical knowledge proper to his calling.

Of the three great weapons of culture here indicated the second is necessary by common consent: but in the judgement of men who have thought deeply on these questions, including not a few of the ablest among mathematicians, it is wholly unfit to be the sole instrument of education. In support of the claims of the third of these prime elementary subjects—

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* The *scientific* side of language-studies is purposely passed over here.

physical science—it may be added that it is signally fitted to counteract some faults alleged, not without reason, to be inherent in the other two—the contempt which the mere mathematician is apt to feel for all reasoning but that which deals with necessary matter, and the tendency sometimes seen in classical scholars to lean too much on authority. It is, again, a characteristic of studies in literature and history that they neither limit us to the impersonal nor to the present, but carry us up through ascending generations from to-day to the remotest past. They thus impress upon us the subordination of one generation to those before it, and the subordination of the individual to the race. Studies of language and literature, of course, have no monopoly of these "humanities;" and, notably, some of the leaders of science in our day are animated by the noblest sentiments in this regard: but this seems due rather to their deep historical sense of the links that bind modern to ancient science than to the inherent tendency of their studies. In some sciences, in fact, the very basis of the teaching may change from decade to decade, and into all the historical method enters only in the slightest measure; whereas the historical and traditional aspects of language-studies are of their very essence. Hence it is that we are compelled to hear so much at once of the exclusively material value of science-studies and of their independence of former times and of all authority properly so called. But this latter feature of these studies—so valuable, as we have seen, from one point of view—if not counteracted or rather supplemented by other influences, is in danger of leading to

the ungenerous question, "Why need we care for our far away ancestors?" and then to the still shallower and ignobler cry, "What have our posterity done for us that we should be concerned for them?"

I have placed the justification of the adoption of a common groundwork of culture for all students on two direct and, as I believe, sufficient pleas. But over and above these direct uses, there are at least two others which I can only indicate: (1) Grace and vigour are lent to social intercourse when men feel that they can trust to the possession by all of a certain general culture—that a common *atmosphere*, so to say, is shared by all; and that subtle criticisms, delicate shades of thought, apt illustrations, will not fall flat on the ears of one-half of those who listen. Those who are familiar with the social history of the first half of this century will agree with me that this element of social life was far more generally present then with cultivated men than it is now. (2) And again, from the want of this common elementary culture, men are without that sympathy with the pursuits of others which tends so powerfully to soften the bitterness of controversy, and even to make fruitful discussion possible.

My chief aim on this occasion has been not to explain with any completeness, or even to defend, except by way of illustration, the details of an academic system. I have endeavoured to demonstrate the principle that, in the choice of studies, men have to consider the claims of the community as well as those of the individual; and further that, if we allow self-seeking to be the prime motive-power, we shall not only overlook the due action of the principle of social benevolence, or

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rather of social justice, but also directly weaken and stunt our intellectual growth. I need not, however, point out to you that both in the intellectual and the moral aspect of this principle, the spirit in which you pursue and apply your studies is far more important than the subject-matter of those studies. If I have expressed the fear that in our day the temptations are great, or at least the tendency is strong, to seek private and selfish aims alone in education, I would not be understood to mean that this temptation is confined to those who study directly with the view of entering on the practice of some profession. On the contrary, there are some branches of professional study which, either from their subject-matter, or from the professional uses to which they lead, are comparatively free from this danger. The physician or surgeon, for instance, is almost driven, in spite of himself, to regard his skill and learning chiefly as gifts which he is bound to use, in Lord Bacon's noble words, "as a rich storehouse for the glory of the Creator, and the relief of man's estate." The temptation to misconceive the true spirit of the student is not less strong, perhaps stronger because more subtle, for those whose special calling it is to devote themselves to a life of study and research. If those err who seek knowledge solely "for the gain it gets," they also err, though less meanly, who seek it "for the praise it brings, the wonder it inspires, the love it breeds." Nay, even he who strives "to know for knowing's sake" falls short of the true dignity of his calling.

If the ideal I hold up to you seems to be difficult and almost impossible, this is the price we pay for our

complex nature, with the wants of the brute that must be supplied, but also with the higher aspirations and duties of the man. I ask you to

> "Rejoice we are allied
> To that which doth provide
> And not partake, effect and not receive;
> * * * * * *

for

> Nearer we hold of God
> Who gives, than of His tribes that take, I must believe."

Your studies will have failed to bring you one of their chief goods, whether as regards the discipline of the intellect, or the indirect, but not less valuable, training for practical life, if you find yourselves too easily satisfied with your success. The mechanical difficulties in the way of the student of former days must have tended to strengthen his character and to ennoble his career; and the very lessening of the drudgery of study, consequent on improvements in the routine work of teaching and the ampler supply of books and of apparatus, will not prove an unmixed gain if it simply smooths the path for you, and leaves you content with the same elevation.

> "Then, welcome each rebuff
> That turns earth's smoothness rough,
> Each sting that bids nor sit nor stand but go!
> Be our joys three-parts pain!
> Strive, and hold cheap the strain;
> Learn, nor account the pang; dare, never grudge the throe!"

I have spoken of some moral aspects of your, or rather of our, work in this place. There is another quality which I will especially commend to you on a day when many are entering for the first time on the

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student-life—I mean the quality of courage and self-control. Of students who begin a term with high aims how many year after year fail to fulfil them, not from want of ability or opportunity, but from want of resolution! The poet Cowper was once consulted by his friend, Mr. Unwin, about some man's character. "All I know," he wrote, "about him is, that I saw him once clap his two hands upon a rail, meaning to leap over it; but he did not think the attempt a safe one, and so took them off again." This story typifies the career of not a few who promised something better. Let me counsel you to keep your hand upon the rail, even if you fail to clear it at the first leap, or, at all events, only to remove it in order to try a humbler height. You are often exhorted to aim high that you may secure a lower mark—

> "Who aimeth at the sky,
> Shoots higher much than he that means a tree."

But I am not sure that it is not wiser to select for the immediate mark, however ambitious your ultimate hopes may be, something fairly within your power, and pertinaciously to strive until you hit it.

And now, in the name of my colleagues, the professors and lecturers, I bid you welcome to the new Owens College. Ours, as you know, is a young institution. We have but lately passed our legal majority; and these spacious and stately buildings, with their costly and elaborate appliances, represent rather our aspirations and the generous expectations of our friends, than our actual achievements. Let it be our common task to see that those expectations are not falsified. One of the best omens for Owens Col-

lege—and I know that this holds good also of the important professional school which we have lately incorporated—is the close tie that has always subsisted between learners and teachers. Not a few old students and some old teachers are here to-day to bear witness of this, and many others are with us in spirit. Let us hand on the tradition unbroken to our successors.

I have already alluded, in passing, to the munificent public subscription which has given us the noble home opened to our use to-day. A more direct and fitting commemoration of this gift will, no doubt, be made in the further proceedings of this morning. I may be allowed, I trust, as one of the very few who have had a share in the work of the College from its opening in 1851 down to the present time, to record our grateful recognition of the long series of benefactions which have come to us during that period—from the gift of the old college buildings by George Faulkner to the bequest by the late Bishop of Manchester of his large and most valuable library.*

To these benefactors of former years, many of them no longer among us, and chiefly to the memory of our Founder, I venture to call for your grateful regards, even in the presence of those whose liberality we more

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* By a happy coincidence, now that this Library has been placed in a receptacle not unworthy of it, a bust in marble of Dr. Lee, the work of Mr. Matthew Noble, has been presented to the College. Cordial acknowledgments are due both to the sculptor, whose skill has carved so faithful a likeness under unusual difficulties, and to the gentlemen who have placed this memorial of an eminent scholar, and an early and constant friend of the College, among the books he loved so well.

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especially commemorate to-day. Others have honoured his memory by raising these noble buildings to bear his name. It is for you, and for us, to see that the immaterial College, which alone he was concerned to found, shall be not less worthy of him.

J. G. GREENWOOD.

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II.

Original Research as a means of Education.

The subject of the value of original scientific investigation may be considered from many points of view. Of these, that of the national importance of original research is the one which naturally first engages attention; and it does not take long to convince us that almost every great material advance in modern civilisation is due, not to the occurrence of haphazard or fortuitous circumstances, but to the long-continued and disinterested efforts of some man of science. Nor do I need to cite many examples to show the immediate dependence of the national well-being and progress upon scientific discoveries thus patiently and quietly made. If it had not been for Black's researches on the latent heat of steam, J. Watt's great discovery, which has revolutionised the world, would not have been made. Practical applications cannot be made until the scientific facts or principles upon which those applications rest have been discovered. In Chemical science I might instance hundreds of cases in which discoveries made in the pure spirit of scientific inquiry have (generally in the hands of others than the original investigators) led to results of great importance to civilisation. Chloroform was first prepared

by Liebig in 1834; but it was Simpson who long afterwards applied it to the relief of suffering humanity. Faraday in 1825 discovered benzine, and from it Zinin prepared a substance called aniline, which for many years remained a chemical curiosity only interesting to the scientific man. In due course, however, a practical sphere of usefulness was to be opened out for this little known substance. Perkin discovered that this rare body was capable of yielding splendid colours. Commercial skill then at once seized upon aniline, and, instead of its being made by the ounce, it is now manufactured by thousands of tons, and the bright and beautiful colours which it yields are known all the world over, and are alike pleasing to the eye of the connoisseur of fashion and of the dusky denizen of the forest primeval. Thus, too, the purely scientific researches of Schunck, respecting the dyeing principle contained in the well-known madder root, laid the foundations for the subsequent discovery, by Graebe and Liebermann, of the artificial production of this naturally occurring principle, termed alizarine, the manufacture of which is now assuming such gigantic proportions. Again, the discovery of chlorine by Scheele, in 1774, lies at the foundation of the whole of the Lancashire trade, for without bleaching powder the cotton and paper manufactures could not exist on their present extended scale. I might almost indefinitely extend this list of discoveries, which, when first made, were apparently far removed from any useful application, but which suddenly came to form the starting-point of a new branch of industry, and a source of benefit or gratification to mankind.

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This subject of the national importance of original research is one which is gradually, but surely, forcing itself on public attention. A few years ago national elementary education was looked upon as a chimera; now it has become the question of the day. As soon as English people see clearly the imperious necessity for encouraging, stimulating, and upholding original research as containing the seeds of our future national position, they will not be behindhand in securing the free growth of those seeds. It is, therefore, the bounden duty of all those whose employment or disposition has led them to feel the truth of this great principle, to leave no stone unturned to make widely known and keenly felt the importance of the national encouragement of original investigation.

For although all agree that genius can be created by no system, and that Newton, Shakespeare, or Faraday, would have proved themselves great under all circumstances of life, yet it must surely be admitted that to give free scope to original power is of the highest importance, and that to place those who possess this natural gift in such a position, both by training and encouragement, as may enable them to use it to the best advantage, is a matter well worthy of the attention of the nation.

It might have been a useful task for me to contrast what is done in other countries for the encouragement of free inquiry and research, and what is done, or rather left undone, in England. We should have seen that on the Continent of Europe, to a great extent, and in the United States, in some measure, those who have to wield the sceptre of government

are not only aware of the national importance of original research, but, what is more, that they act up to their convictions, whilst we feel that the same cannot be said of our country. We should have seen that in France numerous laboratories specially devoted to research are now being established, while in Germany the facilities given in the universities, which are Government institutions, and in the other numerous and well-organised scientific educational establishments, to original research are very great; that an original investigation in some branch of human knowledge is considered the usual termination of the student's university career; and that degrees are generally given only when some new observations or experiments have been added to the mass of human knowledge. We should find that the position of a professor is mainly influenced by the amount and quality of his original researches, and that this, and not any secondary or subsidiary, power, as is sometimes the case with us, is taken as the proof of a man's fitness to fill the professorial chair.

It is my wish, however engrossing this view of the subject may be, here to consider another aspect of the question—viz. the educational value of original research; the value of personal communication with nature for its own sake, the influence which such employment exerts on the mind, the effect which such studies produce as fitting men for the active duties of life, and the question, therefore, as to how far original investigation should be encouraged as an instrument of intellectual progress. It may be well, however, before we enter upon this special question, to place clearly

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before our minds what is meant by scientific enquiry in general, and to see how it is related to the studies and habits of mind with which men up to the dawn of the present, or scientific age, have been familiar.

In the first place, then, the essence of the scientific spirit is that it is free and disinterested. If, therefore, any of the habits of mind, studies, or beliefs in which men have hitherto indulged have not been free nor disinterested, in so far they have not been scientific. In the second place, the spirit of true scientific enquiry refuses blindly to submit to tradition or authority. It lays down laws for itself, and will not be bound by any others. Scientific education begins with no preconceived idea in accordance with which everything else must be moulded. It starts in simple communion with nature, and is content to pick up little by little the truth which she is always ready to communicate to patient enquirers. Thus step by step, and generation by generation, slowly but surely, the perfect edifice of science is being built up, and all those who contribute, however insignificantly, to this great work, have the safe assurance that their labour has not been in vain. This process is, it is clear, at once opposed to, and, if successfully carried out, subversive of, the old method of education which, partly because it has been chiefly guided by those whose culture is in the main dependent on authority and tradition, and partly because a system of pressure is much easier to carry out than one by which the intellectual powers of the student are allowed gradually to develope, must perforce tend to degenerate into purely dogmatic teaching.

Between a system based on authority and one

founded on freedom of thought and opinion there can never be any united action; and while fully acknowledging that intellectual eminence, and, of course, moral excellence, are common to all classes of men, and are not confined to those holding particular opinions, if only they be honest, it is as well that we should admit with equal candour that the followers of the old system have no claim to be called scientific, and that there is, from the nature of things, a great and impassable gulf between us and them.

It does not concern us at present to inquire which of these two systems, the free or the authoritative, is for the future to rule the world. It must now suffice for us to see clearly that the habits of mind necessary for the establishment of the one are absolutely opposed to those needed for the success of the other.

It must not, however, be thought that I undervalue or wish to depreciate the study of subjects other than those included under the head of the physical sciences. Literary studies, whether of modern or ancient authors, giving an acquaintance with the noblest thoughts and opinions of the great men of past ages; historical studies, giving us a knowledge of the acts of men in times gone by; the study of language and philology, as giving a knowledge of how men of all times and countries express their ideas; of logic, as pointing out the laws of thought; and above all, that of mathematics, are educational instruments of the highest importance, the neglect of which must render our culture one-sided and incomplete. The same rules, however, which we acknowledge to be necessary for the teaching of physical science must be applied to the study

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of all these subjects. For, although we allow the necessity in the beginning of the study of every subject that we should accept for the time certain fundamental points as true, and make knowledge of these imperative, still the further progress of the student is to be made by the help of an intelligent appreciation of the grounds upon which the various facts or phenomena presented to him rest, and not by a blind, unquestioning acceptance of the statements which he finds in print, or of the dogmatic assertions imposed upon him by the teacher.

How little the educational value of such a system of scientific training is as yet understood even in quarters where a juster appreciation of its importance might have been expected, is seen in an essay recently published by an eminent Cambridge mathematician, who, in treating of experimental science, expresses his doubts as to the necessity of anything more being required than perfect reliance on the statements made in good faith by a trustworthy teacher, "probably a clergyman of mature knowledge, recognised ability, and blameless character," overlooking altogether the insight into the subject gained by the student in observing the phenomena with his own eyes. As well might it be urged that it is quite useless to visit a foreign country when a description by a conscientious traveller can be read so much more easily! It is thus clear that the *scientific method* must be employed in all cases and carried out to its fullest extent, whilst attempts to shackle the mind, or to stifle free inquiry, which have too frequently succeeded in past times, and which may, if we are not on our guard, succeed again, must be repelled with all our vigour.

I would, however, here wish to protest against the supposed materialistic tendency of scientific studies. It is true that certain opinions and professions of belief have been and will be shaken by studying the book of nature; it is also equally true that such studies do not and cannot interfere with the highest and noblest aspirations of the mind of man. In the investigations of every branch of science we come at last to a point at which further enquiry becomes impossible, and we are obliged to acknowledge our powerlessness and insignificance. We can see and learn concerning only the minutest fraction of the great whole of nature, and it is with this minute fraction alone that we as men of science are concerned.

In endeavouring to point out the educational advantages to be gained by original scientific research as applied to chemistry, we must guard against the error of supposing that it is in this branch of the study of nature only that such advantages are to be obtained. I choose this science chiefly because with it alone I feel competent to deal, although I also believe that, from the nature of things, chemistry serves better than any other science as a field for calling into active exercise the abilities which original investigation undoubtedly promotes.

Nor is it right, as some ardent admirers of modern ideas seem to have done, to suppose that the power of original investigation is confined to the physical sciences. The researches of the historian, the logician, the philologist, or mathematician, are of course as truly scientific as those of the student of physical phenomena, but the difficulties attending the prosecution of original work in these departments is cer-

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tainly greater, and, therefore, the possibility of employing research in these subjects as an educational instrument is less to be looked forward to than in the case with the physical sciences—at any rate, with chemistry. For the adaptation of a subject to the application of investigation as a means of education depends upon the stage of developement which that subject has attained, as well as upon the nature of the phenomena with which it deals. Three-quarters of a century ago, no clear-sighted man could touch any branch of physical science in a determined manner without making some valuable discovery; the difficulties of doing so are at the present day greater, but even now there are not only new fields to be laid open by the experienced and earnest investigator, but there are districts in abundance where, if the general features are known, there still remain details to fill up in the determination of which a sphere is open even to the young student of science. In chemistry especially is this the case. The preparation and analysis, for instance, of a group of bodies for whose existence we have analogical evidence, although not perhaps affording an example of the highest kind of original work, is yet one in which many, at all events, of the qualities needed for the establishment of great scientific discoveries are brought into play, and one which may with benefit be carried out by the intelligent student.

In literature, history, philology, and logic the case is different. Any real progress made in these subjects implies a complete knowledge of the great mass of the facts and conclusions accumulated by generations of scholars, and thus investigation, leading to any new

results, is put out of the power of the young student, and research in these subjects is necessarily confined to mature and master minds.

Let me next endeavour to point out the nature of the preliminary stages through which the student of chemistry has to pass to reach the portal of original inquiry.

The soundest mode of instruction in the principles of chemistry is of two distinct kinds: (1), by lectures, accompanied by experimental illustration by the lecturers, as well as by recapitulatory and tutorial classes; and (2), by experimental work practically carried out by the student himself in the laboratory. Both of these means of obtaining command over the facts and principles of our science should be carried on simultaneously; the lectures serve as giving a general view of the main features of the subject; the laboratory work brings the student into direct contact with Nature, and gives him an insight into her processes, which can only thus be obtained. In the lecture-room the student forms an idea, as when looking at a panorama, of the general appearance of the country; but it is in the laboratory, as in a walk through a given district, that he first learns what the land he is travelling through is really like. And although we know that we must spend much time and labour if we go on foot, we know also that we shall be rewarded by a vivid and lasting impression, and one which may perhaps give a new colour to our lives. It is thus with the study of chemistry; the laboratory is the place where the details of the science are really mastered; and a man must not expect to become a competent chemist without

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having passed several years of hard and unremitting toil in solving the sometimes tedious and difficult problems which are presented to him.

In practical laboratory work we first seek to give the student some notion of the kind of phenomena with which the science is concerned; we then begin to train him in manipulative dexterity, and, by a graduated series of examples and exercises, make him acquainted with the fixed and exact quantitative laws upon which our science is founded. From the beginning a strict system of note-taking and of carrying out simple chemical calculations ought to be introduced, so as to insure a firm foundation for the subsequent superstructure. The student then begins to learn the properties of the more commonly occurring amongst the sixty-three elementary bodies of which (as far as we are yet aware) the material world is built up, and becomes acquainted with the properties of their compounds. He commences the study of qualitative analysis, and at last he is able to ascertain the nature of the exact constituents of any substance, whether of earth, of air, or of sea, of mineral, vegetable, or animal nature, which he may be asked to examine. He has accomplished a great work, and if he has carried his examinations as far as the reactions of the rare elements, he is master of the first or qualitative stage of the science. Next arises the question as to the quantity of each constituent present in the given substance, and the second or quantitative stage is reached. This is necessarily a longer and more difficult matter than his preceding task. Not only must the choice of methods of separation and estimation be successful,

so as to employ good methods and eschew bad or inaccurate, but skill in manipulation must also be forthcoming. All depends on accuracy and care in performing delicate operations, such as weighing, collecting, and washing precipitates, and a hundred other manipulations, and the results of many days' work may be in a moment lost by one false step or one careless action.

In this ordinary course of laboratory work the hand is gradually trained to perform the various mechanical operations, the eye is at the same time taught to observe with care, and the mind to draw the logical inferences from the phenomena observed. Habits of independent thought, and ideas of free inquiry, are thus at once inculcated; no authority besides that of the senses is appealed to, and no preconceived notions have to be obeyed; the student creates for himself his own material for observation, and draws his own conclusion therefrom. If he is inaccurate either in his manipulation, his observations, or in his conclusion, nature soon finds him out. Something or other is out of order, and he is sent back with the task of finding out his mistake for himself.

Not until this preliminary work has been done, and these habits have been formed (and very often not then), is the student fit to think about original research. Before he can successfully grapple with new difficulties he must have learned to overcome the old ones. His hand must be dexterous and accustomed to meet all the mechanical difficulties which invariably accompany such investigations; his eye must not only be open to what he expects to see, but, which is far more diffi-

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cult, it must quickly seize upon the occurrence of phenomena which he does *not* expect to see; his mind, working, perhaps, with a leading thought—for without this, original work is almost impossible—must be free in its power to grasp any new combination of ideas to which the phenomena may suddenly and unexpectedly give rise, and be willing at once to relinquish a favourite and cherished hypothesis if the results of experiment prove that hypothesis to be erroneous. This dexterity of hand, quickness and keenness of sight, and pliability of mind, must in greater or lesser degree be possessed by all who would undertake original scientific work. I do not mention as a preliminary necessity a competent theoretical knowledge of the phenomena and laws of the particular science, because, though this is a matter of course, many having this knowledge will altogether fail, owing to their not possessing the other requisites.

In carrying out, then, even the simplest original investigation, some or all of these requirements are needed. In addition, other faculties are called into play by the very fact of the phenomena being, in part at least, new. Not only do we ourselves not know what to expect, but nobody can tell us what will happen. We are exploring new country, and our outlook must, therefore, be doubly keen; we must be prepared for every possible event, and ready to meet every change of fortune. We must, like a traveller, not be discouraged by reverses, but patiently persevere in our course, feeling convinced that the path, which for a long time may be a thorny one, must in due course lead us to a point from which we shall enjoy an

extended view of the surrounding country, and be abl to trace the tortuous paths by which the elevation wa reached. And here we must carefully guard again the popular and misleading notion that scientific di coveries are made in a haphazard manner, so that i may fall to the lot of even the mere dabbler in scienc to light upon a great new truth. To the outsider discovery may, indeed, appear to be made in such chance way, but the student of the history of science or the discoverer himself, knows better, for he i acquainted with the gradual and often unseen step which have led up to the result. He is aware of th years of patient work, perhaps bearing but little frui which have been the necessary precursors of the fina triumph ; he knows at what cost of time and strengt the man of science has arrived at the position whic enables him at once to notice and appreciate the valu of some phenomenon which to the untrained eye, an the unqualified mind, appears trifling or unmeaning but which in reality serves as the long sought fo solution of some great problem.

As in common life he who best knows how to mee the many difficulties and to utilise the various oppor tunities which life presents is the successful man, so i scientific discovery he is successful who is able t seize upon and rightly understand the meaning of th phenomena which all eyes witness but only those o the seer can interpret.

But here it may be urged, is it possible by educa tion to create this keenness of vision ? Is it not gift which can neither be made nor marred ? To this would reply that, whilst originality of mind is an artic

which cannot be manufactured, it is a useless, and even a dangerous possession, unless its actions are guided by law and order, and just as the greatest genius amongst painters and sculptors can do nothing unless he has put himself through a long training both in the theoretical and practical studies which underlie his art, so the man of science must, if he is to do any work in furthering knowledge, subject himself to a similar course of patient preliminary work. This then is the aim and object of all great schools of systematic scientific research; in them the student is taught the methods of experimentation and observation necessary in order to lay the foundation of future discovery. Men of great and exceptional powers may, indeed, do this for themselves, but, for the ordinary mind, such a training under a master's eye is absolutely essential. It is the absence of great schools of this kind in all branches of physical science which we in England have at present to deplore, it is to the existence of numerous centres of the kind in Germany that we must attribute the extraordinary scientific activity for which this latter country has during recent years been famous.

It must not, however, be thought that because we are ill supplied with schools of research that the national genius of the Englishman is unfavourable to scientific discovery; for there is no doubt that, on the contrary, looking back at our national achievements, we have had the privilege of starting even more than our share of the most important discoveries made in science, and that these have been subsequently worked out and extended in every direction in other countries.

The faculties which are called into active operation in the prosecution of experimental scientific research are, in fact, precisely those which are valuable in the every-day occurrences of life, the proper employment of which leads to success in whatever channel they may happen to be directed. A man who has learnt how successfully to meet the difficulties, and overcome the obstacles which occur in every experimental investigation, is able to grapple with difficulties and obstacles of a similar character with which he comes in contact in after life. It is the greatest possible mistake to suppose—as, unfortunately, many still do—that a scientific education unfits a man for the pursuits of ordinary professional or commercial life. I believe that no one can be unfitted for business life or occupations by the study of phenomena, all of which are based upon law, the knowledge of which can only be obtained by the exercise of exact habits of thought, and patient and laborious effort. No doubt many who have had a scientific education make bad men of business, but so do many who have not had such an education; it is not the scientific education which has spoilt them. Even more directly does the value of high scientific education bear upon professional and manufacturing life. The medical man's success depends mainly upon the exercise of faculties which are pre-eminently called forth and strengthened in original scientific investigations. The manufacturer who aspires to something more than following the rule-of-thumb work of his predecessors, requires exactly these habits of mind which are developed by original research. If the brewer. the calico-printer, the dyer, the alkali-maker,

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the metallurgist wish to make any advance of their own in their respective trades, they cannot do so without the exercise of powers which can only be gained by the prosecution of original enquiry. Doubtless many—nay, even most—of the great discoveries and improvements in the arts and manufactures may have been made by men who have been self-taught. But these men have acquired for themselves, by slow and difficult steps, the same habits of exact observation, patient and laborious devotion, and manipulative or constructive skill which the modern student of science may, at any rate to a very considerable extent, gain in his college course. So valuable is this kind of education found to be, that in Germany, as I am informed by Professor Kolbe of Leipzig, where it is most practised, the chemical manufacturers now refuse to take young men into their works unless they have not merely had a scientific education, but also have prosecuted original investigation.

It is unnecessary for me to point out the direct applications which the knowledge and experience gained in the laboratory receive in the arts and manufactures dependent upon chemical science. These everyone can see for himself. The ordinary routine work of such manufacturers as those already instanced, calls immediately for chemical knowledge, and men who do not yet see the value of the training afforded by original experimental investigation, are ready enough to appreciate chemical knowledge if it can show them that their drugs are adulterated or their water impure.

It seems to me, then, that if education in its widest sense has for its objects, as I presume will be generally

allowed, the training of the mind and faculties in such a way as most fully to qualify the possessor to discharge with benefit to mankind his duties in after life, surely plans for the encouragement of original scientific research should form no inconsiderable portion of the programme of every institution professing to deal with the higher education of the country. And yet when we come to look at the provision made for encouraging original research, either at our older or at most of the more modern seats of learning, we are astonished to find that this essential provision has hitherto been almost altogether ignored. At Oxford and Cambridge thousands of pounds are each year lavished upon the encouragement of classical and mathematical attainments, whilst the claims of original research can scarcely be said to be recognised. Hence these highly endowed Universities, whilst they are justly celebrated for their critical faculties, have ceased to represent in any one direction the productive power of the country.

Original research, the true life-breath of progress, does not in England, as is the case in Germany, look to the Universities as the nurseries where its young shoots shall be tended and cherished, for there, at present, its value is scarcely recognised. Indeed, Sir William Thomson has expressed his opinion that the system of examinations at the Universities has a tendency to repress original enquiry, and exerts a very injurious effect in obstructing the progress of science. The time is, however, possibly not far distant when this want of appreciation of the value of original research will be a thing of the past, and when the Universities will vie with each other in encouraging

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this mainspring of progress, and in honouring those whose lives are devoted to this high calling. Indeed, we may look forward in this direction with confidence to the establishment of a better state of things. Many of the active-minded amongst university men are fully alive to the necessity of such a change, and already both Oxford and Cambridge have made preparations in the foundation of laboratories, as instanced by the noble gift of the "Cavendish Laboratory" by his Grace the Duke of Devonshire, in which the study of the physical sciences can properly be carried to the highest point. With men like Adams, Foster, Maxwell, and Stokes, at Cambridge, and Clifton, Odling, and Rolleston, at Oxford, surely something ought to be accomplished in the vitalization of the sleepy hollow into which, as regards independent scientific investigation, the Universities (with a few great and honourable exceptions) have fallen. The difficulties, however, which those who wish to place physical science in its true position in the Universities have to overcome are extremely great; the prestige of a system which has been going on for generations cannot be easily altered or destroyed; even now it is to be feared that the conceptions respecting the value of scientific studies, and of the abilities of those who devote themselves to these subjects, held amongst the mass of the Oxford and Cambridge undergraduates are of the falsest and most ignorant kind. Nor is it difficult to see the cause of this want of appreciation of the scientific habit of mind, coming, as a large proportion of those entering the Colleges of Oxford and Cambridge do, from the great public schools, where the whole system is one in which

science is either entirely ignored, or, what is worse, scientific teaching is introduced under such unfavourable conditions as to importance (relative to other subjects in the school curriculum) as to degrade it to a mere amusement, and make it the laughing-stock of those who have been forced to learn in other ways what serious work means.

The truth is that it is a misfortune for the country that our two great Universities have both long since ceased to be national institutions, inasmuch as those who benefit from their enormous endowments now belong, as a rule, to the higher classes of society. This gives a class-colouring to all their actions, it hinders the equal and free developement of all branches of intellectual activity, by encouraging those needed or desired by one class, to the exclusion of those which other classes require: in a word, it prevents the establishment of a true university, in the highest and best sense of the term, and lowers that which should be a centre of culture and of progress in every branch of human knowledge, alike used by, and suited to, the prince and the peasant, into a mere finishing school for the more wealthy portion of English society. The great secret of the enormous influence which the German (and I may, perhaps, add the Scotch) Universities have exerted, first, on the general culture of the people in whose midst they have been so wisely placed, and secondly, on the actual progress of science, is their popular character. They are institutions held dear, and made use of by every class amongst the people; hence their universal character, and hence the possibility of their securing from amongst

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the ablest of all classes—from those who have the power to resist the deadening influence of wealth, as well as from those who have, happily for themselves, never felt this influence—men capable and desirous of devoting their lives to the furtherance of some special branch of human knowledge. Owing to the want of means of promoting original investigation in our great seats of learning, the scientific activity of the country has found vent through other channels. No want of encouragement can repress really great minds or powerful wills. Such men as Dalton and Joule are great, in spite of our systematic negligence of the subjects the mastery over which has made their names immortal. And since in respect of men who have, like these, advanced science without external aids, we in England are, and have been, rich, so that, in face of much that is discouraging in this want of recognition of science, we have still no reason to fear the comparison of our great men of science with those of other countries, we may feel sure that our position among the nations will be raised when the Government, our Universities, and the country at large, become alive to their duties as regards the encouragement of original scientific research, and when the number of able men who devote themselves to this pursuit shall thereby be largely increased.

In solving the difficult question of University reform, as concerned with the advancement of science, much assistance may confidently be expected from the Royal Commission on Scientific Instruction and the Advancement of Science, of which his Grace our President is Chairman, and which has lately published its

third report on the progress of scientific education and research in the two old Universities. In this report the importance of original research, whether from a national point of view, or as an educational instrument, is fully recognised, whilst the means of enabling the Universities to take their due share in the management of this branch of human activity is suggested. The evidence given before this Commission by Sir Benjamin Brodie, Professor Frankland, Dr. Carpenter, and other competent authorities, is of the most decided and unanimous character, and not only as a result of that evidence, but also as expressing their own opinion, the Commissioners report as follows:—*

"On no point are the witnesses whom we have examined more united than they are in the expression of the feeling that it is a primary duty of the Universities to assist in the advancement of learning and science, and not to be content with the position of merely educational bodies. We entirely concur with the impression thus conveyed to us by the evidence, and we are of opinion that the subject is one to which it is impossible to call attention too strongly. We think that if the Universities should fail to recognise the duty of promoting original research, they would be in danger of ceasing to be centres of intellectual activity, and a means of advancing science would be lost sight of, which, in this country, could not easily be supplied in any other way. There is no doubt that, at the present time, there is a very strong feeling in the country in favour of the wide diffusion of education, and of the improvement of all arrangements and appliances which tend to promote it, from the simplest forms of primary instruction up to the most advanced teaching that can be given in an University. But there is some reason to believe that the preservation and increase of knowledge are objects which are not as generally appreciated by the public, and of which the importance is not so widely felt as it should be. On this point we would direct especial attention to the remarks of Sir Benjamin Brodie: 'For education we construct an elaborate and costly machinery, and are willing, for this end, to make sacrifices; but, on the other hand, the

* Third Report (1873), pp. 184-5.

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far more difficult task of extending knowledge is left to the care of individuals, to be accomplished as it may; and yet it is this alone which renders education itself possible. I really am inclined to think that in former days a more real and earnest desire must have existed to preserve knowledge as a valuable national commodity for its own sake than exists now; and the reason that I say this is, that we have existing in the Universities of Oxford and Cambridge records of another condition of things with regard to knowledge than that which exists at present. In the first place, we have extensive libraries, which could only have been founded and preserved for the sake of the preservation of knowledge itself; and, in the next place, the collegiate foundations in the Universities were originally and fundamentally, although not absolutely and entirely, destined for the same objects. . . . This object is certainly not less important in modern than in ancient society. I presume that in the Middle Ages knowledge would altogether have perished if it had not been for such foundations, and it appears that now, from other causes, the pursuit of knowledge and of general scientific investigation is subject to very real dangers, though of another kind to those which then prevailed, and which make it very desirable for us to preserve any institutions through which scientific discovery and the investigation of truth may be provided. . . . The dangers to which I refer are dangers which arise partly even from the growing perception of the practical importance of knowledge, which causes a very great draught indeed to be made upon the scientific intelligence of the country. In the first place, almost every scientific man is caught up instantly for educational purposes, for the object of teaching alone; and, in the next place, a very great draught indeed is made upon science for economical purposes; I mean for purposes connected with practical life. In sanitary matters we have numerous examples of the vast amount of work done by scientific men for public and practical objects. So that the supply of scientific men is not equal to the demand for these objects alone. Manufacturers offer another great field of scientific employment, and it is to be observed that these are the only ways through which an income can be obtained, the pursuit of scientific truth being an absolutely unremunerative occupation.'

"We believe that the dangers referred to in these remarks are real; and their existence induces us to lay down, as emphatically as possible, the position that the Promotion of Original Work in Science should be regarded as one of the main functions of the Universities, and should be specially incumbent upon the holders of those fellowships which, as we have already recommended, should be awarded with a view to encouraging original research. As regards the Professors, we

have already insisted on the importance of so arranging their duties as to give them abundant leisure, and, what is no less indispensable, abundant opportunities for original investigation, by providing the external appliances necessary for it. We think that the great national interests connected with the advancement of science form one, although only one, of the grounds upon which the endowment of professorial offices is defensible, and regard it as a great advantage that an opportunity is afforded by the peculiar circumstances of the Universities of giving encouragement and maintenance to a class of persons who are competent to advance science, and who are willing to make its advancement the principal business of their lives.'

The signal want of success as regards original results attending the present system of subsidising learning by means of Fellowships as rewards for ascertained merit is acknowledged by all, but the difficulties attending the establishment of any more productive system are indeed great. The main proposals made by the Commissioners are two in number: (1), the establishment of a complete Professoriate; (2), the appropriation, under certain conditions, of Fellowships to the maintenance of persons engaged in original research. In speaking of the first of these, however, they insist (and in my judgment rightly insist) on the necessity of all offices founded within the University having special duties attached to them, so that not only must the Professor be required to further knowledge in his own subjects, but a certain amount of distinct educational work is to be attached to each chair. This is not only desirable for the sake of bringing the student into direct personal contact with the original worker, but for that of the latter himself, who is undoubtedly benefited by having a portion of his time occupied by teaching. The statement of the Commissioners respecting the appropriation of Fellow-

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ships as rewards for accomplished original work, agree so completely with my own views on this subject, that I cannot forbear quoting it.

"We have also already spoken of the propriety of awarding Fellowships in certain instances, not, as at present, by an examination test, but for services rendered to science in original research. Although we should wish, as we have already said, to see this done from time to time (as it has already been done at Cambridge) in the case of persons who have already made themselves eminent in science, and whose accepting the Fellowship is rather to confer an honour upon the office than to receive one from it; we also think that a wider application should be given to this principle; and that, whenever a Fellowship in Natural Science is offered for competition among the younger graduates of the University, such evidence as any candidate can offer of his aptitude to become a useful worker in science should always be taken into account in the award. Nothing, we believe, would tend to give the students at the Universities so just an idea of what science is, or of what the objects are which those who pursue it should have in view, as the adoption of the principle by the Universities and the Colleges, that the highest honours and rewards in Natural Science are to be conferred upon men who can offer some evidence that their names are likely afterwards to find a place on the list of those who have added to human knowledge."

In addition to the above-mentioned recommendations, the Commissioners suggest—(1) that laboratories should be founded expressly intended for research and

for the training of students in the methods of ori investigation; (2) that scientific museums and c tions should be maintained to an extent beyond is required for purely educational purposes; an that a Doctorate in Science be founded, in which candidate should be required to present some ori research, and which should not be awarded exce a great honour, and only then with referenc original work.

The adoption of these or similar suggestion the University authorities, with or without P mentary interference, will doubtless be producti the greatest benefit to those great institutions to the nation at large, but much more swee changes must in my judgment be introduced int Universities, for they must be so altered that benefits are equally thrown open to the poor and t rich. Some means must be found of applying funds of the Universities to the purpose to which founders wisely intended they should be applied the maintenance and encouragement of poor stu of conspicuous merit. As soon as persons i classes of English society who show aptitude scientific research, and are of proved abilities in ways, can obtain the means of prosecuting their st and of learning the methods of systematic inve tion at the University, then, and then only, can great seats of learning be said truly to fulfil their calling.

Unless some course of this kind is pursued Universities will become less and less repres tives of the intellectual progress of the nation,

institutions more adapted to the requirements of the age will be established, and it will be from these that the nation will obtain that help which the Universities are unable or unwilling to give.

To assist in developing amongst the practical community of Lancashire the appreciation of scientific research, and owing to the liberality of Manchester men and to the wise advice of Professor Frankland, who then occupied the chair which I have now the honour to hold in this College, a scholarship for original chemical research — our Dalton Chemical Scholarship — was founded in 1853 as a testimonial, and a fitter one could not have been proposed, to our great townsman. The establishment in England of a scholarship for excellence in original research was, twenty years ago, a circumstance without a parallel, but in spite of the novelty of the experiment, time has fully proved the wisdom of the course which its originators adopted. We can already point to a fairly long list of men who have taken our Dalton Scholarship, who now hold high and responsible positions in scientific, manufacturing, and official life; and these men will all acknowledge the benefit conferred upon them by the training they received when competing for the scholarship, and whilst occupied for the first time in their lives in carrying out an investigation on some original subject.

On the model of our Dalton Chemical Scholarship, an important physiological scholarship has lately been founded in this College; the conditions of tenure involve the prosecution of an original investigation in physiology; and it is to be hoped and expected that this scholarship will do as much to stimulate the study

of physiology amongst us as the Dalton has certainly done in the case of chemistry. The establishment of similar scholarships for the reward of original work in all the schools for the higher scientific training is much to be desired, and benefactions made for this special purpose will assuredly prove of the greatest value.

Concerning the exact mode by which encouragement should be given in this country to original research, opinions may differ. One proposal has lately been made by the distinguished President of the British Association (Professor A. W. Williamson), in his able address at Bradford, which it behoves all interested in the progress of the country carefully to consider. In this address we find, for the first time, the question of the advancement of science brought before the British Association not from the point of view of what has been already achieved, but of what remains to be done. How science is to be advanced in our country is the subject-matter of his discourse.

Without attempting to discuss the merits of his or other schemes, it may be well to point out those general features of the subject upon which there cannot well be much difference of opinion.

In the first place, then, all will agree that the measures which have to be taken must be systematic, must apply to the country at large, and must include all classes. What we need is the developement of the latent intellectual resources of the country as regards science, the means of sifting out from the great mass of the people those golden grains of genius which now are too often lost amongst the sands of mediocrity. This can only be fully accomplished by a system ex-

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tending from the lowest primary schools up to the highest educational establishments in the land, and, therefore, almost necessitates the action of Government. But whilst believing that a national system is needed in order that the potential scientific energy of the country shall become active, I for one should most strongly object to the establishment of a complete system of State education. One of our greatest safeguards and sources of national strength has been, and is, the freedom from Government control which our educational, municipal, and local institutions have always enjoyed; and the evils of a uniform State system as existing in France (which is such that the Minister for Education remarked, with pride, that at a given moment the classes in all the Lycées in France were engaged in reading the same chapter in Cæsar's *Commentaries*) need only be felt to be deplored.

In Germany, on the contrary, although the Universities and Polytechnica are Government institutions, their internal and educational arrangements have been from time immemorial untrammelled by Government interference. Indeed, twenty or thirty years ago, the Universities were the only corporations in Germany in which freedom of thought and opinion was freely expressed, or in which it could even be said to exist. The complete *Lehr- und Lern-Freiheit* of the German Universities has been one great secret of their success. If the Professors had been cramped by Government dictation as to the methods of teaching, or if the students had been all ground down to the one pattern by the requirements of competitive exami-

nations, originality of mind would have been effectually discouraged.

The value of this *Lehr- und Lern-Freiheit* is well seen in the great German science schools which have effected revolutions in their respective subjects of study. Thus the Giessen School of Chemistry, under Liebig, was the first in which chemists were systematically educated. Hundreds of young men, attracted by the name and talents of the great investigator and teacher, streamed from all parts of the world for thirty years to the otherwise somewhat insignificant University of Grand Ducal Hesse to learn from Liebig what original chemical investigation meant. Many of the more talented of these returned to their own countries to carry on the noble work of extending the boundaries of our knowledge of Nature and to found laboratories for research and instruction on the model of that in Giessen. Following in Liebig's steps other great masters have arisen, and have extended and developed the system of teaching which he originated. The schools of Wöhler in Göttingen, of Bunsen in Heidelberg, of Kekulé in Bonn, and of Hofmann in Berlin, and many others, have all largely contributed to forward our science by the researches of the Professors and those of their numerous pupils, and in no case could any of these results have been obtained, if, instead of the spirit of free enquiry reigning supreme, the energies of both teacher and student had been cramped by competitive examinations. So widely, indeed, has the influence of these foreign schools of science made itself felt that I believe it would be difficult, amongst the hundreds of men scattered throughout

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the world who are now contributing to the extension of the science, to name a dozen who had not at some period of their career either studied themselves in one of the great laboratories of Germany, or been trained by some one who had experienced the advantages which Germany thus generously throws open to all nations.

What is needed in this country appears to be a somewhat similar system to that existing in Germany of State-aided Universities or high schools for science situated in suitable positions throughout the kingdom (for I take it that Oxford and Cambridge, even when placed on a proper basis, cannot possibly supply all the higher education of the country), each of these having a distinct local executive, and each, therefore, being free (under certain wide conditions, so as to prevent abuse of funds) to follow out the particular line of instruction or research best suited to the requirements of the locality in which it is placed, and to the class of men for whose education it has to provide.

Secondly, it is clear that in order to be able to select from amongst the people those whose mental and physical powers fit them for ultimately advancing science themselves, the rudiments of a scientific training must be much more widely diffused than is at present the case. This can only be slowly accomplished; the methods of teaching science are only beginning to be understood, and, unfortunately, in school-teaching the introduction of a scientific subject has too often been looked upon more as an amusement than as a study requiring as much, or more, attention

and exactitude than the older subjects, and as one which, when properly taught, acts to quite as great an extent as a mental discipline. Science teachers have yet to be trained, and a system of introducing elementary science as disciplinary teaching into primary and secondary schools has yet to be made general.

Much has been done by the Department of Science and Art to spread a knowledge of the principles of science amongst the people. Indeed, the number of science classes held throughout the country has year by year increased to such an extent that at present the candidates for the May examinations in one single subject (Chemistry) number 4289. And although the actual knowledge of the science to which those attending these classes attain may as a rule be small, yet the influence which this wide-spread system of science teaching will have on the people can hardly be overestimated.

The next step which has to be taken in the general scientific education of the country in this direction is, in my opinion, that of the establishment of a systematic method of training science teachers of all grades. Up to this time payment on results has been the plan acted upon by the Department, teachers are taken from those who have passed a certain standard examination, but no recognised and thorough mode of creating a class of highly trained teachers has been adopted, although an experimental laboratory training for schoolmasters has been commenced at South Kensington. For this purpose new institutions have to be founded in which the higher branches of the various sciences shall be taught and original research

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encouraged, and into which youths of conspicuous merit must be drafted, whilst existing colleges and Universities have to be modified to suit the requirements of the time. These institutions must contain laboratories, not only for teaching purposes, but suited for scientific research, and the Professors must take in a certain number of advanced students to work on original investigation. This is, indeed, as Sir Benjamin Brodie points out in his evidence before the Commission, an educational function of the most important character; because here scientific education is carried out to its end, and, if this is not done, you stop short of the most important part of all in scientific education, for the perfection of science as a means of education is seen only in scientific Enquiry. The pupils thus trained will eventually pursue science as their main business in life, and become in their turn teachers and professors of their subject. Thus, by degrees, the profession of the investigating teacher will become recognised as one in which the ablest of our youths may obtain reward and recognition, as well as satisfaction and delight, and thus the scientific power of the country will be vastly increased.

On the ennobling nature of original scientific enquiry it is needless to enlarge, for although I should be the last to contend that men of science are free from the foibles and weaknesses common to all mankind, I think it stands to reason that the habits of mind which an investigator must cherish are such as must raise him above the petty struggles of ordinary existence, and must, for a time at least, lift him into an atmosphere free from the cloud and smoke which too often darken

the usual current of men's lives. In order to give an illustration of what original research consists in, and to point out the interests attaching to an enquiry, the practical applications of which seem as far distant as those of a newly discovered planetoid, I may quote a case of the kind with which I happen to be familiar. Among the sixty-three different elements of which the earth, so far as we know, is made up, there are many which have been found only in the most minute quantity. A few only of these rare substances are employed in the arts and manufactures, or are known to play any part in the economy of nature; the rest are substances of interest at present only to the scientific chemist. It would, however, be presumptuous on our part were we to assume that the existence of these bodies is a matter of no moment, for we are constantly learning that substances hitherto supposed to be useless are of the most vital importance. Hence it is obviously our duty to get to know all we can about the properties of each, even the rarest, of these elementary bodies, and especially about their relation to, and mode of action on, the other elements. It is clear, too, that as long as our knowledge of the properties of any one of these elementary bodies is inaccurate, or if mistaken views regarding any one have arisen, our science must suffer in completeness. For just as an error made in the basement of a house throws the upper storeys wrong, so a mistake concerning the size and shape of the foundation-blocks of our science may render the whole chemical superstructure faulty.

In 1830 the great Berzelius fully examined a new elementary body termed Vanadium, the existence of

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which had been previously discovered by his countryman Sefström. Having most carefully ascertained the remarkable properties of this new substance, and its compounds with the other elements, Berzelius gave to vanadium and its compounds a certain chemical position and place amongst the other elements. Thus to the compound of vanadium and oxygen containing the largest proportion of the latter element, and which we therefore call vanadic oxide, he assigned the formula $V_2 O_3$, meaning thereby, in the atomic language of our great Dalton, that two indivisible particles or atoms of the metal are combined with three indivisible particles or atoms of oxygen: and these views, enforced by experiments of the most unimpeachable character, were for years universally adopted by chemists.

In 1858 a fact was observed by the German chemist, Rammelsberg, with regard to the crystalline form of the best known mineral containing vanadium which exhibited Berzelius's conclusions in a new light. It had long been known that substances which have an analogous chemical composition are found to crystallise in an identical form. Thus the different alums containing alumina, oxide of iron, oxide of chromium, oxide of manganese, all crystallise in octahedra; and the oxides contained in these alums have all an analogous composition; that is, the relations between the number of atoms of metal and of oxygen in each case is identical. Now, Rammelsberg found that the crystalline form of a mineral contained vanadic oxide, and lead was identical with another mineral containing phosphoric oxide and lead. Hence we should expect to find that the oxide of vanadium, termed vanadic oxide,

and the oxide of phosphorus, commonly called phosphoric oxide, possess an analogous chemical constitution. Such, however, was found not to be the case. Phosphoric oxide is well known, and, without doubt, consists of two atoms of phosphorus, united with five atoms of oxygen; whereas Berzelius only found three atoms of oxygen to two of the rare metal in vanadic oxide. How is this discrepancy to be explained? We have here to do either with an exception to the otherwise general law of isomorphism, so that we may have identity of crystalline form, without any analogy in chemical composition, or Berzelius's experiments and conclusions respecting the constitution of this vanadic oxide are incorrect. By experiments on the properties of vanadium and its compounds, made with much larger quantities than it fell to the lot of the Swedish chemist to work with, it was shown that something had been overlooked by him. It was proved that the substance which he supposed to be a metal was not a metal at all, but an oxide, and that vanadic oxide really contains more oxygen than he believed it to contain. And the remarkable fact is that this quantity of oxygen, which had been overlooked, is exactly the quantity which is needed in order to make the constitution of vanadic oxide identical with that of phosphoric oxide. We have to take out of each atom of Berzelius's metal one atom of oxygen in order to get the true vanadium, so that the real atomic weight of this element is less than that given to it by Berzelius by the atomic weight of oxygen, $67{\cdot}3 - 16 = 51{\cdot}3$. Thus the chemical constitutions of phosphoric and of vanadic oxides are represented by the formulæ $P_2\,O_5$ and $V_2\,O_5$ respectively.

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The law of isomorphism remains unassailed, and the goddess (Vanadis is a cognomen of the Scandinavian goddess Freia) who was found wandering as a waif and stray amongst her companion elements, has been restored to her natural friends, and now forms a recognised member of a family group.

To sum up, my aim in the foregoing remarks has been to show that if freedom of enquiry, independence of thought, disinterested and steadfast labour, habits of exact and truthful observation, and of clear perception, are things to be desired as tending to the higher intellectual developement of mankind, then original research ought to be encouraged as one of the most valuable means of education. And that on this ground alone, and independent of the enormous material benefits which such studies confer on the nation, it is the bounden duty not only of the Government, but of every educational establishment, and of every citizen of this country who has the progress of humanity at heart, to promote and stimulate the growth of original research among us.

HENRY E. ROSCOE.

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III.

Solar Physics.

. Our knowledge of the sun has of late years greatly ncreased; of old our luminary did two things for us—ike a benevolent parent he smiled upon us, while at the same time he kept us in leading strings.

We are told * how Professor von Poddingcroft used to illustrate this twofold action, and how in the course of one of his lectures the learned Professor, seizing a bucket of water, swung it round his head; the bucket, which was a substitute for the earth, describing a circular orbit round the globular head and ruby visage of Professor von Poddingcroft, which formed no bad representation of the sun. We are also told how he informed his students that, should the motion of the earth be suddenly checked, it would incontinently fall into the sun, a most ruinous event to this planet, and one which would also obscure, though it most probably would not extinguish, the solar luminary. Whereupon, the historian informs us, an unlucky stripling, desirous of ascertaining the correctness of the experiment, suddenly arrested the arm of the Professor just at the

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* Knickerbocker's *History of New York.*

moment when the bucket was in its zenith, which immediately descended with astonishing precision on the philosophic head of the instructor of youth. A hollow sound and a redhot hiss attended the contact, but the theory was in the amplest manner illustrated. For the unfortunate bucket perished in the conflict, but the blazing countenance of Professor von Poddingcroft emerged from amid the waters, glowing fiercer than ever with unutterable indignation, whereby the students were marvellously edified, and departed considerably wiser than before.

2. Such an illustration is now completely out of date. The sun is already known to do more than this, and is likewise suspected of doing much more than we positively know of; his appearance and actions have therefore come to be studied with much interest and not a little success. In fact, by gazing anxiously and often into the face of our great luminary, we have come to recognise certain delicate changes of expression and meaning, so that we may be said to have taken our first lesson in Solar Physiognomy. The following sketch of what has been done in this respect may fitly be prefaced by a very few words regarding the principles which underlie solar research. These preliminary remarks will naturally group themselves into two divisions, the one treating of the qualities of substances as regards the radiation and absorption of heat and light, while the other treats of atmospheric changes and their causes.

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The Radiative and Absorptive Qualities of Substances.

3. It will hardly be necessary here to discuss the principles of spectroscopic analysis or to lengthen this Essay by an account of what must be already well known to all. Suffice it to state, that in general, luminous bodies, such as the sun, give out a very great many different kinds of rays. The sun's beams are white or colourless, but contain, nevertheless, an almost infinite number of rays of different qualities and varieties of colour, all blended together in such proportions that no tint is in excess, and the general impression on the eye is a pleasing white. Now, just as in chemical analysis we can separate the various constituents of a compound substance and tell what these are, and in what proportions they are mixed together, so in spectroscopic analysis do we separate the various constituents of a compound beam of light and tell what these are and in what proportions they are mixed together. By this method of analysis we have already learned much regarding the nature of the rays given out by heated substances.

4. *In the first place* it is found that an incandescent solid or liquid substance gives out, if sufficiently hot, all the various rays of light. Thus, in the well-known carbon or electric light, we have all the rays given out, and it is consequently probable that the particles which give out these rays are small solid or liquid particles. In like manner the general surface of the sun gives out all varieties of rays, and hence it is probable

(though not absolutely certain) that the particles which give out the chief portions of the sun's light are incandescent solid or liquid particles. We are not, however, able to state the exact chemical nature of the liquid or solid particles that give out such light.

5. *In the next place*, it is found that incandescent gases and vapours do not give out all the various kinds of light, but only a very few; and it is also probable that no two elementary vapours give out the same kinds of light. The consequences of this law are of the utmost importance, for it follows that if an elementary gas, or mixture of elementary gases, be ignited, by analysing spectroscopically the nature of the light which it emits, we can tell what substances have gone to form the ignited mixture, since each substance invariably gives out its own peculiar rays, and these are different from the rays given out by any other substance.

Whenever, therefore, we see traces of individual colours in a luminous body, we may be sure that this arises, not from incandescent liquid or solid substances, but from ignited vapours, probably metallic.

Thus ignited sodium vapour produces a light entirely yellow, as may be seen by burning sodium itself or some compound of that metal.

6. *In the third place*, we learn that if a substance when hot gives out certain rays of light, when cold it stops these very rays if placed as a screen between the eye and the source of light. Thus, we have seen that incandescent sodium vapour gives out an intensely yellow line, which, examined spectroscopically, consists

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of two rays, and which is therefore known as the double line D.

Now, if some comparatively cold sodium vapour be placed between the eye and some luminous solid or liquid body that gives out all varieties of rays, it will stop that very double line D, so that when the light proceeding from the combination comes to be examined, the double line D will be found to be wanting, or nearly so. It follows from this that if, upon examining spectroscopically the light of a luminous body, we find the double line D to be wanting, we may be perfectly certain that some comparatively cold sodium vapour exists between our eye and the source of light.

7. In connexion with this subject it is curious to remark the strange analogies that hold between very different laws, thus exhibiting a strong family likeness between the various branches of the tree of knowledge. To illustrate this, let us begin with the theory of sound. We have in sound a law that is precisely similar to that which regulates the connexion between absorption and radiation. In order to exhibit this analogy we have merely to place the two laws side by side in the following manner :—A body when *cold absorbs* that *light* which it gives out when *heated*. A string when *at rest stops* that *note* which it gives out when *struck*. The next analogy is doubtful, but, nevertheless, deserves a place. "*Similia similibus curantur*" forms the motto of the homœopathists, and we have likewise the well-known, if somewhat vulgar, proverb, "*Swallow a hair of the dog that bit you.*" Now, both these sayings imply the belief of those who use them, that a substance which causes a certain disturbance in a

healthy frame will cure the same disturbance in those cases where it is present beforehand.

The next is a very curious analogy, coming from a very distant and unexpected quarter—I mean the law of *retribution in kind*.

Thus we read in the Book of Judges how Adoni-bezek, when captured by the Israelites, had his thumbs and his great toes cut off, and, in the very next verse, he owns the justice of his punishment, telling us how he had treated in a similar manner threescore and ten kings. We learn, too, from the somewhat apocryphal records of early Greece how Theseus constituted himself an itinerant administrator of this very law, and how in one of his journeys he fell in with Procrustes, or the Stretcher, whose peculiar notions of hospitality induced him to adapt his guests to the size of his bed by pulling them out when too short and cutting them down when too long. We are further told how Theseus undertook to play the part of host to Procrustes, who required to be altered in order to suit the size of his own bed.

These illustrations are sufficient to convince us that the human mind acquiesces in a certain adaptation between the offence and the punishment. It is considered peculiarly fitting that a man should fall into the pit which he has digged for others, and it is held to be right that one who from his inward heat and passionate fury has given out,—has *radiated*,—has inflicted a certain punishment upon others, should by the hand of justice be forced to become an unwilling recipient of the same.

8. But to return from this digression. We learn *in*

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the fourth place that if a luminous body be in rapid motion either towards or from the observer's eye, it will not appear to give out precisely the same rays which it would have done had it been at rest.

This principle was first suggested by Fizeau, and afterwards successfully applied by Dr. Huggins in ascertaining the motions of the stars, and by Mr. Lockyer and others in measuring the velocity of storms in the sun's atmosphere. We may best explain it by help of a similar phenomenon in sound. Suppose that a railway engine is rapidly passing a station and whistling at the same time,—of course to the driver of the engine it will continue to give out the same note, but to an observer standing on the platform the note given out by the engine when it is rapidly approaching him will be shriller than that which it gives out when it is rapidly receding from him. Now a ray of light is very similar to a wave of sound, and if we replace a whistling engine by a luminous body, a similar change will take place in the nature of the light seen by the observer, according as the body is approaching him or receding from him. There is, however, this difference:—the luminous body will require to move with an immense velocity before the change of ray can be appreciable, and hence it is only in the case of celestial motions that we can obtain a change sufficiently great to enable us to perceive it by means of the spectroscope.

9. It may now be desirable to bring together the various facts regarding absorption and radiation, to which reference has been made.

Firstly. We have the fact that incandescent solid

and liquid bodies, if sufficiently hot, give out all the various kinds of light.

Secondly. Incandescent gases and vapours give out only a few kinds of light, and no two elementary gases give out the same kinds.

Thirdly. A gas or vapour, when cold, absorbs those very rays which it gives out when hot.

Fourthly. When a luminous body is rapidly approaching the observer, its rays appear to be of smaller wave length (equivalent to shriller in sound), and when such a body is rapidly receding from the observer, its rays appear to be of greater wave length (equivalent to less shrill).

Atmospheric Motions and their Causes.

10. In order to arrive at the causes of meteorological changes, whether occurring on the sun's surface or on that of our earth, we cannot do better than study an ordinary fire. We have here a carriage of hot air up the chimney, which ultimately mingles with the cold air outside, and, again, we have an in-rush along the floor of the room of cold air destined to become heated in its passage through the fire, and ultimately as hot air to mingle with the cold air above. Thus an in-rush of cold, and an up-rush of hot, air may be said to be the characteristics of such a fire, and if the heat be great and the chimney narrow the rush of air may be very violent. Now here we have a true meteorological result,—a wind, a current of air;—and the cause of this wind is evidently due to the heat of the fire.

We have, in fact, two bodies of different tempe-

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ratures—the fire and the cold air—and we have, also, a wind or current produced during the carriage of heat from the hotter to the colder body,—from the fire to the air outside. Now, these two things invariably accompany each other, and whenever we have visible motion produced, whether in a fire, or in the steam-engine, or in the earth's atmosphere, or in that of the sun, we may be sure this is accompanied by a carriage of heat from a hotter to a colder region.

11. But let us return to the fire. The heated air ascends to the top of the chimney, because it has been expanded by heat, and is, therefore, less heavy than the cold air around it.

Now, evidently, the ultimate cause why a less heavy body ascends, whether in water or in air, is the attraction of the earth. If the earth did not attract bodies there would be neither up nor down, and rarefied air would have no tendency to move in one direction rather than in another. But the attraction of the earth depends upon its mass. If, therefore, we could imagine the whole interior of the earth, with the exception of its crust, to be suddenly removed, whatever else might happen, one thing would certainly be altered for the worse—our chimneys would not draw nearly so well as they did before. On the other hand, were the mass of the earth increased, the violence of the draught of air up our chimneys would be increased also.

Again, the action of a fire depends upon the intensity of the fire, and also, to some extent, upon its size and that of the chimney; for it is evident that an exceedingly small fire, with a very short chimney,

would not draw well even although the temperature of the fire should be very high.

Thus the up-rush depends upon three things; first of all upon the intensity of the fire; secondly, upon the scale of the arrangement; and, thirdly, upon the force of gravity.

12. Let us now leave the fire, and consider our earth from the same point of view. The hot regions near the equator may be regarded as the fire, and we have there a carriage of the hot air upwards as if through a chimney into the higher regions of the atmosphere, while we have an in-draught of cold air along the ground or floor of the world, from both sides of the equator, to supply the place of the air which has been carried up.

Most probably, too, in the centre of a cyclonic storm, or whirlwind,* we have a similar carriage of air, as if through a chimney into the upper regions, the place of which is supplied by a spiral in-draught of air from all sides, moving often with terrific violence.

13. We have hitherto spoken only of air, that is to say, of a substance that never condenses into a liquid or solid, but remains always in a gaseous state. Let

* Two facts taken together seem to indicate this. In the first place, we have a spiral in-draught of air from the circumference to the centre of a cyclone; and secondly, while this is taking place the already low barometer in the centre is probably continuing to fall. Now, what becomes of this in-draught of air if it be not carried up? This question is discussed by Buchan in his *Introductory Text-Book of Meteorology*, where he says (p. 172): "We are forced to the conclusion that from a large area within and about the centre of the storm, a vast ascending current must rise into the upper regions of the atmosphere."

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us now endeavour to see what would take place were we to deal with a vapour instead of air, that is to say, with a substance, which when sufficiently reduced in temperature, assumes the solid or liquid state, as, for instance, the vapour of water or steam.

To illustrate this we may take an ordinary still used for distilling water or alcohol. Here we have a hot chamber and a cold one—the boiler and the condenser—and if we continue to keep the boiler hot and the condenser cold, a large quantity of vapour, carrying with it a great amount of heat, will pass over from the boiler to the condenser. This passage of vapour may be accompanied with great violence, and with the capacity of overcoming resistance and of doing work. In the steam-engine, for instance, we have mechanical effect, or work produced in great abundance, but always during the passage of vapour and heat from the boiler to the condenser;—in fact, a steam-engine is like a still, except that its object is not to distil over liquid, but rather to make the vapour do work in its passage from the boiler to the condenser.

14. We thus see that vapour is very effective as a vehicle for carrying heat from a hot place to a cold one; and now let us think for a moment what would happen if our earth were a globe of hot water, and if there were no permanent atmosphere, but only watery vapour above its surface. The water would boil, or evaporate, with great rapidity, and then rising up and becoming subject to the cooling influences of outer space—which would in this case be extremely powerful—it would condense into rain, or hail, or snow, which would fall down in frightfully heavy storms to mingle

with the ocean once more. An observer from another planet would never see the true surface of such a world,* for it would be enveloped in one continuous cloud of rain, always falling, but as constantly renewed, and if there were land with mountains, as well as water, one can imagine the terrific violence with which the mountain torrents would rush down towards the sea. But the supposition is an extreme one; we cannot suppose this earth to have been ever without a permanent atmosphere, but we can easily suppose it to have been hotter than it is at present, and hence with more vapour suspended in its atmosphere. Indeed, geologists assure us that the earth must once have been in such a state. We have, therefore, much reason to suppose that in the early history of our earth its meteorological phenomena were much more intense than they are at present, the violence of the wind immensely greater, the rainfall immensely more.

15. It thus becomes apparent that the presence of a condensable vapour in the earth's atmosphere imparts a character of *violence* to the earth's meteorology. I may add that it imparts likewise a character of *abruptness, amounting to incalculability*. To illustrate this point, let us make a supposition which cannot be called extravagant. Let us suppose a stratum of air somewhere

* Possibly the planet Jupiter is in a somewhat similar condition at present. What we see there may be only the cloud surface, and not the true solid or liquid surface of the planet. One strong band in the spectrum of the planet, as observed by Dr. Huggins, corresponds with some terrestrial atmospheric lines, and probably indicates the presence of vapours similar to those which float about the Earth. (See Roscoe's *Spectrum Analysis*, 3rd edition, p. 322.)

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in the earth's atmosphere to be very nearly saturated with aqueous vapour, that is to say just a little above the dew-point; while, at the same time, it is losing heat with extreme slowness, so that, if left to itself, it would be a long time before moisture was deposited. Now, such a stratum is in an extremely delicate state of molecular equilibrium, and the dropping into it of a small crystal of snow would determine a change of state, just as it would if dropped into water cooled below the freezing-point, only from a different cause.

For what would happen? The snow would cool the air around it, and thus moisture would be deposited around the snow-flake in the shape of fine mist or dew. Now, this deposited mist or dew being a liquid, and giving out all the rays of heat possible to its temperature (Art. 4), would send its heat into empty space much more rapidly than the saturated air; and therefore it would become colder than the air around it. Thus more air would be cooled, and more mist or dew deposited; and so on until a complete change of condition should be brought about. Now, in this imaginary case, the tiniest possible flake of snow has pulled the trigger, as it were, and made the gun go off,—has changed completely the whole arrangement that might have gone on for some time longer as it was, had it not been for the advent of the snow-flake.

16. We thus see how in our atmosphere the presence of a condensable liquid adds an element of violence, and also of abruptness, amounting to incalculability, to the motions which take place. But this must not be understood to imply that we cannot come to any true knowledge of terrestrial meteorology. On

the contrary, we have already obtained very valuable information, which it is of the greatest importance we should increase. What is meant is, that our knowledge of meteorological phenomena can never be mathematically complete, like our knowledge of the motions of the planets, inasmuch as there exists an element of instability, and, therefore, of incalculability, in virtue of which a very considerable change may result from a very small cause.

17. Let us now bring together what has been stated regarding atmospheric motions and their causes.

We have seen that winds denote currents which carry heat from hotter to colder places, and that their intensity depends—

Firstly. On the intensity of the heat of the hot parts as compared to that of the cold.

Secondly. On the force of gravity.

Thirdly. On the scale of the arrangement.

Fourthly. Such currents are augmented in violence by the presence of a condensable substance in the atmosphere.

Fifthly. And are also thereby rendered abrupt, and, to some extent, incalculable, in their operations, inasmuch as a small cause may produce a very great effect.

Appearance of the Sun's Surface.

18. Having thus discussed the principles which are to guide us in our investigation of solar phenomena, let us next consider what, in point of fact, the sun is, and what sort of changes take place upon his surface.

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It is difficult to realise the vastness of the sun. Suffice it to say that a globe representing the sun, on the scale on which an ordinary globe represents the earth, would fill a very large building. Like the earth, the sun revolves on his axis, but only once in twenty-six days.

19. Now, before discussing solar observations, we must remember that, while the sun shines by his own light, the earth shines only by the light of the sun. If we except the occasional flash of lightning, the auroral displays, and perhaps also, under certain atmospheric conditions, a dim phosphorescent luminosity, the earth is dark. It is not all equally cold, for we know that the Equator is much hotter than the Poles, but none of it is sufficiently hot to give out light of itself; it is all certainly very much below red heat. It follows that an observer, constituted as we are, regarding our earth from neighbouring space, would not be able to tell which were the hot and which the cold portions of it; at least he would not be able to do so by his eyesight alone. Not so, however, when a body becomes self-luminous. If we look into a fire we can tell at once which are the hottest and which the coldest parts of it, and we can do the same if we look at the sun. We are sure the cold parts will be more black or less luminous than the hot parts. Now, as a matter of fact, we find all over the sun's surface, when we use a telescope of sufficient power, a peculiar mottled appearance, consisting of luminous patches, separated from each other by rows of small dark dots, the intervals between these dots being extremely small, and occupied by a substance decidedly less luminous than the

general surface. This appearance was first observed by the elder Herschel, and has since been described, under varying aspects, by Dawes, Nasmyth, Secchi, and others.* We have said that we cannot see things in our earth by their own light; but if a shower of hail, or snow, or cold rain, could write its temperature upon the retina by means of its own rays, we should perceive it to be comparatively dark. This leads us to ask if the black patches and dots on the sun's mottled surface may not possibly denote showers of celestial hail or rain, formed, of course, of something else than water.†

20. Let us now study a little more closely this mottled surface, and let us call it the Photo-sphere, or light-giving surface. It is apparently a mottled, and most probably a pitted surface, the black portions of which denote, perhaps, descending showers of solar hail or rain, and its appearance is continually varying, being thus very different from the moon's surface, which always remains the same; in fine, it is a cloudy surface, and not a surface of continuous fluid, like our oceans, or of continuous solid, like our dry land.

Let us next imagine ourselves transported to this irregular, intensely heated, but yet mottled surface.

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* See Lockyer's *Contributions to Solar Physics* (Macmillan and Co., 1874).

† See *Preliminary Researches in Solar Physics*, by Messrs. De la Rue, Stewart, and Loewy. See also a Lecture entitled *The Sun and the Earth*, by the Author of this Essay (*Manchester Science Lectures for the People*, 1872-3). Professor C. A. Young, of America (*Nature*, September 11, 1873), likewise suggests the existence on the sun of a crust consisting of a more or less continuous sheet of descending rain, made, of course, of something else than water.

and let us explore it more closely, especially near the equatorial regions of the sun. Perchance we may come to the brink of an awful cavern or solar pit, great enough in area, if not in depth, to swallow up many worlds like our own. This pit would probably have irregular, sloping, cloudy sides, and an irregular bottom three or four thousand miles deep, or even more. Its sloping sides would be less bright than the surface over which we are supposed to travel, and its bottom still less bright, so that we should have two gradations of darkness, in consequence of which we may call the sides the *penumbra*, or half shade, and the bottom the *umbra*, or whole shade. Here is a picture * of such a chasm seen through a powerful telescope.

21. But if we speak of these sun-spots as chasms, our readers are entitled to ask a proof for such an

* The writer is indebted for this and the other woodcuts to Mr. Lockyer, author of a recent work on *Solar Physics*, and to Mr. Macmillan, the publisher of that work.

assertion. To this we reply that Professor Wilson of Glasgow, in 1774, was the first to prove the cavernous nature of sun-spots; nor was any one more surprised than he himself when he made the discovery. The surprise even led to a temporary denial of the conclusion, but of late years we have become certain of the cavernous nature of these appearances. In order to apprehend this proof, we must bear in mind that the sun rotates on his axis about once in twenty-six days from left to right, and that consequently all sun-spots appear on the left-hand side of the sun, taking about thirteen days to cross his visible hemispherical surface. Now, when a spot first comes round by the left side, the penumbra nearest the centre is hidden from our view; at the centre we see everything, both umbra and penumbra, but as the spot disappears at the right side or border of the sun the penumbra next the centre is once more hidden, and we see only that farthest off. This behaviour of

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sun-spots was first observed by Wilson; he saw that they behaved as if they were pits with sloping sides, and came to the conclusion that they were in reality caverns of this nature.

Another reason in favour of these spots being hollows is derived from the fact that bright matter has been seen to sail across a spot leaving everything the same as before, just as a bird might fly across the mouth of a pit while it would be lost in a cloud. A third reason is derived from the spectroscopic observations of Lockyer, who finds that the light which reaches us from the matter at the bottom of a spot is such as to denote the existence of a greater atmospheric pressure or denser state of things than at the surface of the sun. Now in the sun, just as in our own atmosphere, a great pressure corresponds to a great depth. All these facts go to show that sun-spots denote depressions in the cloudy surface of the sun.

22. Having thus described the large black patches or sun-spots, let us say a few words regarding certain peculiarly bright patches, called *faculæ*, which are generally seen to accompany spots.

As we have three reasons for imagining sun-spots to be depressions, so we have at least two reasons for imagining faculæ to consist of the luminous matter of the sun thrown up high into the solar atmosphere. One of these is derived from the fact that the faculæ are generally behind the accompanying spot as regards the direction in which the sun is rotating. This can easily be explained on the supposition that the faculæ represent matter which has been thrown up from a

region below or nearer the sun's centre to a region above or further from that centre, in which case the matter would fall behind, inasmuch as it comes from a region of less to one of greater velocity of rotation.

Another reason for imagining the faculæ to represent matter high up is derived from the fact that they shine out much more brilliantly when near the sun's rim than when near his visual centre. To appreciate this evidence let us reflect why the sun should appear to us much more brilliant at noon than at sunset, so that while the eye cannot bear his light in the one position, we can frequently gaze upon him with impunity in the other. The reason is that near the horizon his light is absorbed by a vast thickness of the earth's atmosphere. It follows that if by any means this atmosphere could be taken away, the sun would gain much more near the horizon than near the zenith, for it would make a great difference in the one case and hardly any in the other. But the sun has himself a large absorbing atmosphere, which stops part of the light from the photosphere below it, and the border of the sun's disc corresponds to our horizon, and his visual centre to our noon, so far as thickness of this atmosphere is concerned, and thus we see why the luminous matter of the sun should appear to gain more when transferred from the bottom to the top of the solar atmosphere near the sun's border than when the same operation takes place near the visual centre of the disc.

Inasmuch, then, as faculæ hardly shine out at all near the sun's centre, while they shine out prominently

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near his border, we are disposed to think that they consist of matter existing at the top of the sun's absorbing atmosphere. And inasmuch as such faculæ appear to have fallen behind, we conclude that the matter composing them has been carried to its present high place from a lower elevation.

23. We have thus arrived at the conclusion that sun-spots are depressions and faculæ elevations in the cloudy surface of the sun; let us now consider the various ways in which the same object may be viewed. A tree, for instance, may be viewed in *elevation* or on a *ground plan*. We may view it, as we generally do in elevation, projected against the sky as a background; or we may view it, as a bird does, by getting above it, and seeing it projected against the earth as a background. In the first case it forms a most picturesque and beautiful object, but in the latter it does not appear to advantage. Now, these up-rushes of solar matter may also be viewed in these two ways. Generally they are seen as a bird sees a tree; that is to say, projected against the sun's face or disc; but when they take place at the very rim or border of the sun, they may be seen projected against the sky beyond, if we view them in a proper manner.

24. Have we, then, only to point towards the sun's rim a telescope sufficiently powerful, with a dark-coloured glass sufficiently strong, in order to see these up-rushes in elevation? We reply that they cannot be seen by any such method, and the reason for this we shall now explain. Suppose that a large quantity of brown sugar and a small quantity of sand are mixed together and we wish to see the sand; how shall we

proceed? We shall pour in, of course, a large amount of warm water and dissolve the sugar, when the sand will be left behind. Now the up-rushes at the sun's rim are invisible from the very cause which renders the sand when mixed with the sugar invisible; we have around the sun's border too much glare from the general body of the sun reflected by the earth's atmosphere, and this glare must either be removed or dissipated before we can distinguish the up-rushes. During a total eclipse this glare is simply removed. The dark body of the moon conceals the bright disc of the sun from our earth, and there is no glare, and hence, during such eclipses, the up-rushes become visible in the form of red flames, or protuberances, which are seen to surround the sun on such occasions.*

But these total eclipses have been very trying to the patience and temper of scientific men. They occur so seldom, at such distant and unlikely places, they last so short a time (only a few minutes), and, finally, to crown the vexation, when the astronomer has at great trouble, expense, and loss of time, put himself into a position for utilising these few precious moments, a shower of rain, or a cloud, renders all his efforts of no avail. Nevertheless, this vexation has borne good fruit. It has led men of science to ask themselves the following question: If we cannot remove this glare,

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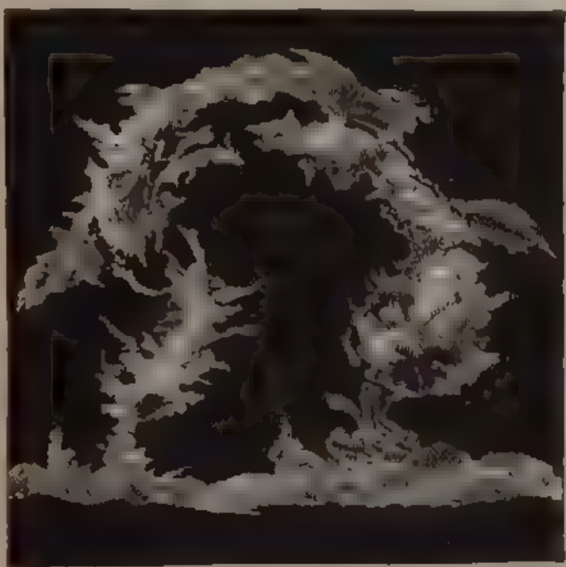
* These red flames are on such occasions most prominent round those parts of the sun's border which the body of the moon leaves most exposed, and Professors Grant (of Glasgow) and Swan (of St. Andrews) appear to have been the first to conjecture from this, that in reality these flames envelope the whole disc of the sun, thus forming a solar appendage. Their solar origin was first satisfactorily proved by Mr. Warren De la Rue.

can we not disperse it? Comparing these red flames to the sand, and the glare to the sugar, can we not disperse the glare by a method similar to that by which hot water gets rid of the sugar?

25. This was accomplished, I may say, simultaneously and independently by Janssen in France, and Lockyer in this country. It was found that, by means of the spectroscope, we can dilute and scatter the glare while the light from the red flames remains undiluted, and thus becomes visible.

The light from the glare is ordinary sun-light, and embraces all sorts of rays, and these are separated from one another and scattered; while that from the red flames consists only of a very few sorts of light which are, therefore, not so scattered.

26. These red flames, when viewed by the spectroscope, frequently present a most gorgeous appearance.



Sometimes they exhibit the unmistakable traces of a spiral up-rush, sometimes they are cloudy in form; while sometimes they assume a glorious foliage, forming gigantic fiery trees, of which the tops are, perhaps, 100,000 miles above the surface of the sun. Now these red flames are intimately connected with faculæ; and, according to Lockyer, we may probably regard the red flames as forming the upper part of an up-rush seen projected against the sky, while the faculæ form the lower part of it seen projected against the surface of the sun.*

27. It has already been stated that the light which proceeds from a luminous body is slightly changed in character if the body be in rapid motion either to or from the observer. By analysing the light from the red flames we can thus tell whether they are in rapid motion either to or from the eye, and by this means enormous velocities have been detected, amounting, on some occasions, to the almost incredible speed of 100 miles per second, while 30 or 40 miles per second is quite a common occurrence.

28. The next point of interest is to know the chemical composition of these vapours, or gases, which play such a very active part in solar phenomena. The first step in this direction is due to Kirchhoff, the well-known German philosopher. We have already stated (Art. 6) that if, upon examining spectroscopically the light of a luminous body, we find the

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* According to Lockyer we may have faculæ without red flames, but not red flames without faculæ. If the disturbance is not sufficiently great to extend to the upper regions, then we have no red flames.

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double line D wanting, we may be perfectly certain that some comparatively cold sodium vapour exists between our eye and the source of light. Now this double line D is wanting in the light from the sun, and we may, therefore, conclude that some comparatively cold sodium vapour exists somewhere between our eye and the sun's photosphere, or light-plane. Of course this sodium vapour is not in our Earth's atmosphere, therefore it must be in that of the sun. In like manner Kirchhoff was led to conclude that iron vapour, in a comparatively (of course only comparatively) cold state, exists in the solar atmosphere, and likewise the vapours of certain other metals, as well as the permanent gas hydrogen.* These all give out black lines when seen between us and the sun's disc, because, being in the sun's atmosphere, they are colder than the photosphere, or light-giving surface of the sun. They do not, however, behave in this way when seen in elevation at the rim of the sun projected against the sky beyond. When seen against the sun, being comparatively cold, they stop certain rays, but when seen against the sky, which has no light of its own, they are comparatively hot, and give out in a bright form these very rays which they stopped when viewed against the sun (Art. 6). In fine, we can thus analyse the light from the red flames, and find out what they are composed of, just as we can with respect to

* We learn from the recent investigations of Lockyer that the following substances certainly occur in the sun's atmosphere : Sodium, iron, calcium, magnesium, chromium, nickel, cobalt, hydrogen, manganese, titanium, zinc, aluminium. (See *Phil. Trans.*, December, 1872.)

any earthly flame, and we find that the lower parts of them give out bright rays denoting the presence of sodium, iron, magnesium, and other metals; while the upper part of them apparently consists almost entirely of hydrogen. Thus hydrogen plays the same part in the sun's atmosphere as oxygen and nitrogen play in ours, forming the permanent substratum of it, while the vapours of sodium, iron, magnesium, &c., play the same part as our aqueous vapour, confining themselves like it very much to the lower strata of the atmosphere.

29. We now begin to see what a solar storm really is. We have first of all a huge ascending current, consisting of the vapours of iron, magnesium, sodium, and sundry other metals mixed together in an atmosphere of hydrogen. This ascending current or at least the hydrogen part of it, may rise, perhaps, 100,000 miles above the solar surface, mounting with an enormous velocity. Now such an ascending current has its counterpart in the shape of a descending current, consisting of a terrific down-rush of celestial rain and hail at an extremely high temperature, but yet comparatively cold. We must, however, remember that such a down-pour does not encounter a hard solid surface such as it would on our earth, but finds its way down, growing colder and blacker as it descends, until finally it enters into the hot interior of the sun and becomes gradually dissipated. Thus we have the ascending current appearing as a facula and also as a red flame, while the descending current appears as a sun-spot.

30. If it be asked why the meteorological pheno-

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mena of the sun's surface are so extremely violent it is very easy to answer the question. We have only to turn to Art. 17, which tells us the conditions determining the intensity of convection currents, and we find that the solar currents are violent—

Firstly, because the heat of the hot solar surface is very great as compared with the cold space beyond.

Secondly, because the force of solar gravity is very great, being about 28 times greater than that on the surface of our earth.

Thirdly, because the scale of the whole arrangement is very great; and

Lastly, because we have the presence of condensable substances in the solar atmosphere. All these are powerful causes, and their joint result is to swell the violence of solar storms into something like 60 or 100 miles *per* second.

31. Now, this meteorological activity of the sun's surface is very intimately connected with his light-giving energy. It has often been a source of wonder how the sun can incessantly—without weariness and without abatement—continue to give out such enormous floods of light and heat, as we know he does. Of course the machinery for such a continuous effulgence must be very powerful. Now what is this machinery? We reply it is by means of the convection currents of the sun that all this takes place. We can easily see that if the surface of the sun were that of an incandescent solid it would very soon grow cold. Were it a continuous liquid surface there might be convection currents, but these would not be powerful, inasmuch as liquids do not expand through heat nearly

so much as gases. The operation of carrying down the cooled particles from the surface and carrying up new ones from beneath, would not take place fast enough in such a surface. Again, were the sun's surface simply a permanently gaseous surface, we should (Art. 5) have very little light and heat from it, and should have to look for our light and heat to some continuous surface beneath the gas. But a cloudy surface is peculiarly appropriate for the office which the sun has to discharge. For, in the first place, the condensed cloudy particles, being either liquids or solids, give out (Art. 4) all varieties of light and heat; that is to say, they radiate very freely. On the other hand, we have all the mobility and powerful carrying influence of a gas, so that the luminous particles are continually renewed. The interior of the sun is, no doubt, a vast reservoir of heat. Now using the imagery of the old theory of light, the front, or surface particles of the sun, forming a sort of advance column, discharge their light-shot into space, after which they become exhausted and immediately retire downwards, as fast as possible, to give way to others, and to be themselves recruited from the heat magazine below. Thus we have a constant and energetic rush downwards of exhausted soldiers, who have fired their shot, while, at the same time, we have an energetic rush to the front of new men and ammunition. And thus the battle against space goes on without interruption and without diminution, and therefore we live, and are here to speak about it this day.

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Meteorological Connexion between the Sun and the Planets.

32. Having thus given a short description of what takes place on the sun's surface, let me now say a few words about the connexion between this and that which takes place on the surface of our earth.

I have spoken about two kinds of solar storms, *minor* and *major*. We have, in the first place, the universally distributed mottled surface, which represents the minor storm; while the sun-spot, which is confined to those regions around the solar equator, may be taken to represent the solar hurricane or cyclone. Now, sometimes there are a great many such spots on the surface of the sun, while, at other times, there are very few, or even none at all. We are indebted for our knowledge of this fact to Hofrath Schwabe, a most persevering German observer, who mapped the sun's surface every day on which it was visible during the long space of forty years. Table I. (page 88) embodies the results of his observations, giving the number of new groups of spots which have broken out on the sun's surface year by year. From this we may see that the yearly number of these groups is by no means regular, but that, on some years, we have very few, while, on other years again, we have a great many. There are certain years of minimum sun-spots when the numbers are smaller than those on either side, and certain other years of maximum sun-spots when the numbers are greater than those on either side.

TABLE I.

NUMBER of NEW GROUPS of SUN SPOTS observed each YEAR.

(The observations from 1826 to 1863 inclusive were made at Dessau by Hofrath Schwabe, the others were made at Kew.)

Year.	No. of New Groups.	Year.	No. of New Groups.	Year.	No. of New Groups.
1826	118	1842	68	1858	188
1827	161	1843	34	1859	205
1828	225	1844	52	1860	210
1829	199	1845	114	1861	204
1830	190	1846	157	1862	160
1831	149	1847	257	1863	124
1832	84	1848	330	1864	113
1833	33	1849	238	1865	93
1834	51	1850	186	1866	45
1835	173	1851	151	1867	17
1836	272	1852	125	1868	115
1837	333	1853	91	1869	224
1838	282	1854	67	1870	403
1839	162	1855	38	1871	271
1840	152	1856	34	1872	186
1841	102	1857	98		

33. It is natural to enquire if the sun's heat be less on the years of maximum than on those of minimum sun-spots. Apparently, however, there is very little difference in respect of the heating effect of our luminary.* There is, however, some reason to suppose that his actinic † or chemical and ripening effect is

* See the researches of Piazzi Smyth, Stone, and others, who have studied the subject.

† If the sun's disc be viewed by a telescope, the centre is not a great deal brighter than the limb. But if a photograph of the sun be taken, the centre is very conspicuously brighter than the limb, showing that the sun's absorbing atmosphere produces more effect upon his chemical or actinic than upon his ordinary light rays. Now, the Kew

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diminished during the production of spots. Dr. Arthur Schuster finds that the years of minimum sun-spots coincide very nearly with the good wine years in Germany, as may be seen from Table II. Neverthe-

TABLE II.

Exhibiting the near coincidence between the YEARS known as good WINE YEARS in GERMANY and the YEARS of minimum SUN SPOTS.

Dates of minimum Sun Spots.	Years known in Germany as good Wine Years.
1784·8	1784
1798·5	(?)
1810·5	1811
1823·2	1822
1833·8	1834
1844·0	1846
1856·2	{1857, 1858}
1867·2	1868

less we must wait for observations by means of the self-recording actinometer just completed by Dr. Roscoe, before we can be sure of this diminution.

34. But it is not so much the direct and apparent as the indirect and unexpected influence of sun-spots upon terrestrial meteorology, that claims our attention.

In the first place, when there are most solar storms or sun-spots on the surface of our luminary, there are

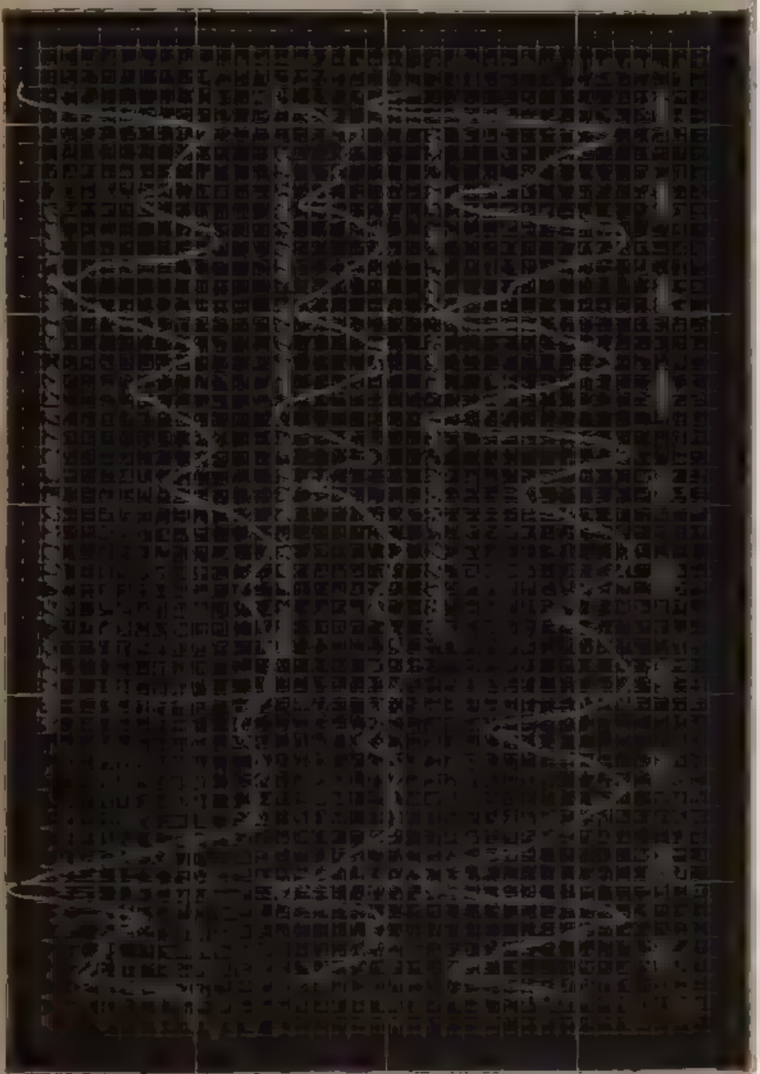
observers have remarked that during years of maximum spots, the shading off from centre to limb is peculiarly marked, so that the sun appears to have in such years an atmosphere of which the absorbing effect is stronger than usual upon the actinic rays. This conclusion has been confirmed by the spectroscopic observations of Lockyer.

most disturbances of the magnetism of the earth. Our earth may be compared to a large magnet, which is not, however, always the same, but varies—often in an apparently capricious and irregular manner. Now, it has been shown by Sir E. Sabine and others that these irregularities depend upon sun-spots, in such a manner that years of maximum sun-spots are likewise years of greatest magnetic disturbance. Again, every considerable magnetic disturbance is accompanied with a display of the Aurora Borealis; and hence during the years when there are many spots on the sun, there will be a great number of Auroral displays. Thus the year 1870 was famous for displays of the Aurora, but it is not, perhaps, so generally known that it was a year of maximum sun-spots. In the following diagram (page 91) Professor Loomis of America has exhibited together the yearly frequency of sun-spots, magnetic disturbances, and Auroral displays, during the last ninety years, and from it we see how very closely these various phenomena march together.

35. In the next place the meteorology of the earth, as well as its magnetism, is affected by the state of the sun's surface. Mr. Baxendell (of Manchester) was the first to show that the convection-currents of the earth vary with the spots on the sun, and, following out a similar line of research, Mr. Meldrum (of the Mauritius) has recently discovered, as the result of about thirty years' observations, that there are more cyclones in the Indian Ocean during years of maximum than during years of minimum sun-spots. The connexion between the two is exhibited in Table III. (page 92).

36. We have thus seen that both the magnetism and

the meteorology of our globe appear to be affected by solar disturbances, and also that these disturbances ex-



SOLAR SPOTS, MAGNETIC DECLINATION, AND AURORAL DISPLAYS.

hibit a curious periodicity. Now, a periodical effect of this kind naturally suggests the existence of a periodical

TABLE III.

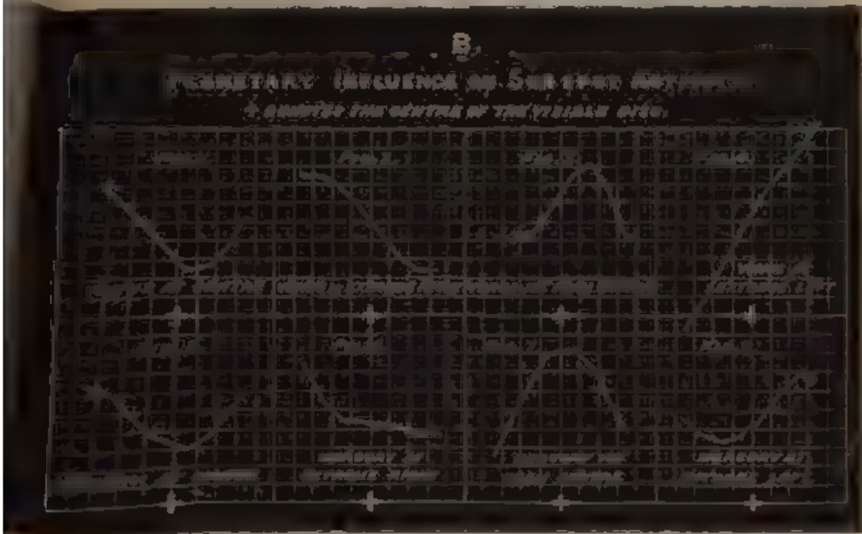
COMPARISON of the YEARLY Number of CYCLONES occurri the INDIAN OCEAN, with the YEARLY Number of SPOTS on the

Character as regards Sun Spots.	Years.	No. of Hurricanes.	No. of Storms.	No. of Whole Gales.	No. of Strong Gales.	Total number of Cyclones.	No. of Cyclon
	1847	5	0	0	0	5	
Max.	1848	6	2	0	0	8	
	1849	3	2	3	2	10	
	1850	4	3	1	0	8	
	1851	4	2	1	0	7	
	1852	5	0	3	0	8	
	1853	1	1	5	1	8	
	1854	3	1	0	0	4	
Min.	1855	3	2	0	0	5	
	1856	1	0	2	1	4	
	1857	2	1	1	0	4	
	1858	3	1	3	2	9	
	1859	3	2	6	4	15	
Max.	1860	7	4	2	0	13	
	1861	5	2	2	2	11	
	1862	4	2	2	2	10	
	1863	5	2	1	1	9	
	1864	2	2	1	0	5	
	1865	2	2	3	0	7	
Min.	1866	1	4	2	1	8	
	1867	0	4	2	0	6	
	1868	3	2	2	0	7	
	1869	3	1	3	2	9	
Max.	1870	2	1	5	3	11	
	1871	3	2	3	3	11	
	1872	6	5	1	1	13	
	1873*	4	5	3	0	12	

* Up to 31st May.

cause, and thus the mind is directed to the revolu of the planets, as being somehow connected with outbreaks. This branch of enquiry has been pur by the Kew observers, whose labours appear to

met with considerable success. These observers have measured every sun-spot recorded by Mr. Carrington, from the beginning of 1854 to the end of 1860, as well as every one photographed at the Kew Observatory from the beginning of 1862 to the beginning of 1867; and the results of all these measurements are recorded in the following diagram. In this diagram each curved



line is supposed to represent the behaviour, as regards size, of the various groups of spots as they pass across the disc of the sun from left to right. If, for instance, a spot were always to retain the same magnitude, its path would be represented by a horizontal line, but if it were to become smaller at the middle of its course than at either extremity, then we should have it represented as in the first figure. Now, from this diagram, we find that whenever either Venus or Mercury is between our earth and the centre of the sun, the sun-

spots behave as in the first figure; that is to say, as they are carried round by rotation nearer to the planet they become less, and as they are carried away from the planet they become greater. Secondly, when Venus or Mercury is at the extreme right of the sun, the spots diminish in size all the way across. Thirdly, when Venus or Mercury is on the other side of the sun, exactly opposite the earth, the spots have their maximum in the centre. And, finally, if Venus or Mercury be at the extreme left, the spots augment in size all the way across; in fine, they are always least in the immediate neighbourhood of Venus or Mercury, and greatest when that portion of the sun to which they are attached is carried by rotation to the position farthest from the influential planet.

37. At first sight we are startled by the supposition that a planet like Venus, which comes nearer to the earth than it ever does to the sun, should in any way be accountable for such enormous manifestations of energy as those which occur over the sun's surface. But the wonder will disappear if we bear in mind that there may be two kinds of causes or antecedents. Thus, we say that the blacksmith is the cause of the blow with which his hammer strikes the anvil, and here the strength of the blow depends upon the strength of the smith. But we may likewise say that the man who pulls the trigger of a gun or cannon is the cause of the motion of the ball, and here there is no relation between the strength of the effect and that of its cause. Now, in whatever mysterious way Venus and Mercury affect the sun, we may be sure it is not after the fashion of the blacksmith—they do not deal him a

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violent blow producing all this enormous effect, but they rather pull the trigger, and immediately a very great change takes place.

Delicacy of Construction.

38. I have thus given, both from theory and observation, reasons for believing that the sun's atmosphere, as well as that of our earth, owing perhaps to the presence of condensable vapour, is in a delicate state of equilibrium, so that a very small cause may often produce a very great effect, and now, in conclusion, it may be desirable to say a few words about this same delicacy of construction.

On a previous occasion * I ventured to introduce certain views as to the position of life in the Universe of Energy, endeavouring to show that the essential physical condition of the existence of a living being (at least such a being as man) is the possession of a frame denoting delicacy of construction. It is no doubt somewhere in the mysterious brain-chamber that the trigger is pulled, and where an exceedingly small motion determines ultimately it may be some very violent action on the part of the individual. Thus, in an animal a very considerable physical effect may be produced by a very small physical cause; and, without pretending to know what life is, we may feel assured that it cannot exist except in conjunction with a frame possessing delicacy of construction. Now,

* See Lecture *On Cosmical Physics*, being the Opening Lecture at Owens College for the Session 1870–71. See also article on "*The Place of Life in a Universe of Energy.*" By B. Stewart and J. N. Lockyer (*Macmillan's Magazine*, vol. xviii. p. 319, 1868).

this delicacy of construction implies instability,—it implies an unstable arrangement of natural forces, and the forces made use of in our frames are evidently those of chemical affinity. The bodies of animals are, in truth, unstable chemical products, the proof of which consists in their speedy decomposition when life is extinct. Thus we see how life, with all its varied possibilities, its free and energetic action, results from those very arrangements of natural forces which under other circumstances produce decay.

39. Now, from what has been said in this Essay, it will be seen that there exists throughout the universe, or, at least, throughout our system, another exhibition of unstable forces besides that which we see in animated structures. We have molecular instability in the atmosphere of the sun, and probably also in that of the earth. As a natural consequence we have great delicacy of construction, or the susceptibility of vast effects being produced from very slender causes, as exemplified in the action of the planets upon sun-spots, and in that of sun-spots upon the meteorology and magnetism of our globe. Thus we perceive in the universe generally, as well as in our own frames, the existence of delicacy, and the question naturally occurs: Can the universe in any sense be regarded as an animated structure in which, as in our own frames, intelligence* may assume great freedom of action without the subversion of the fundamental laws of energy? While we cannot from the physical point of view pretend to reply to this question, we should

* Perhaps even many intelligences.

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yet wish to indicate what is conceived to be the true position of physical science with regard to it.

40. In the first place, it is very difficult to separate the physicist from the man. I see one man shoot another, but what do I see as a physicist? Why, first of all, I recognise a conversion of the energy of the gunpowder into the visible energy of the bullet; going back a little further, I trace the bestowal by means of the forefinger of a certain amount of energy upon the trigger; going back a little further, I know that this bestowal of energy denotes a certain consumption of muscular fibre, and also a certain minute change in the matter of the brain.

Thus, as a physicist, I can only arrive at a physical antecedent,—nay, even the hideously triumphant face and glaring eye of the murderer have from this point of view none but physical antecedents. But yet I know as a man that the act was a foul murder, and will do my very best to bring the murderer to justice, whatever be my ideas with respect to the position of life in the Universe of Energy. Thus, as a physicist, I recognise the delicacy of construction which appears to be necessary to the embodiment of intelligence, but I cannot tell whether intelligence be there or not. My reasons for believing that it is there have nothing to do with physical science; they are derived from the consciousness that I myself exist, and from the conviction derived from powerful reasons of an analogical nature that my fellow men are beings similar to myself.

41. But, again, when we regard the varied motions of an animated being, we find that these are of two kinds:—some are as nearly as possible mechanical,

as, for instance, the beating of the heart and the circulation of the blood, which are not even spontaneous, and certainly convey no moral meaning whatever; others again are spontaneous and convey unmistakable indications of a moral agent.

Now, in the universe there are also certain motions that are strictly mechanical. We have the great tide of being, the life-blood of the universe, coursing through its immeasurable arteries, through which it will no doubt continue to circulate until the universe be no more. Unquestionably there is no moral significance in such motions; if the moon crosses the meridian when we do not expect her, what do we do? why, only revise our calculations. But it has been shown in this Essay that there are other motions of the universe associated with that element of delicacy which does not characterise the orbital motions of the heavenly bodies. Now, if a physicist be asked whether he has any reason to associate these motions with the spontaneous acts of intelligence directing these motions after a manner similar to that by means of which our intelligence directs our motions, his reply will be that he cannot tell. Recognising the principle of delicacy, he may have no objection to urge, but the reasons for or against such an hypothesis must be derived from other sources, and the battle must be fought with other weapons than those of the physicist.

42. In concluding this short sketch of an incomplete but interesting problem it ought to be mentioned that the results hitherto achieved have been chiefly obtained through the efforts of private individuals, who have bestowed much thought, time, and money upon the

problem. By these means it has been brought to such a state of advancement that it becomes a question of national importance to continue the research. It has in fact become evident that we must study Solar Physics in order to arrive at the causes which influence the meteorology of our earth.

Let us therefore hope that, under these circumstances, the enlightened governments of the earth, in virtue of their police functions, may see the propriety of setting a watch upon the sun, being, as he is, a creator of disturbances on the greatest possible scale, while ever ready to afford us information about himself at the smallest possible cost.

BALFOUR STEWART.

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IV.

The Distance of the Sun from the Earth.

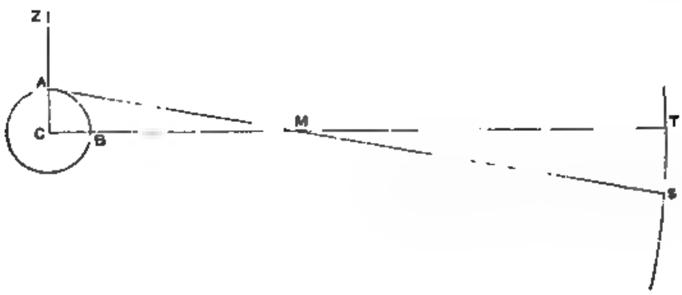
It is well known that within the last twenty years astronomers have been induced to believe that the sun's distance from the earth has been considerably over-estimated, and that instead of being 95,000,000 miles, it is more probably only 91,000,000. The difference, though absolutely large, is relatively small, being a trifle more than four per cent. of the whole, and is the same as if in measuring the angular diameter of a distant object, say with a theodolite, an error should be made equal to the very small angle under which the breadth of a human hair would be seen at a distance of seventy-two yards. This small angle, about the ten-thousandth part of a degree, is more easily named than conceived. If the divided circle of the theodolite has a diameter of six feet, the length of a degree on its circumference is a little more than six-tenths of an inch, and the ten-thousandth part of this would require a very powerful microscope, magnifying about a thousand times, to make it visible.

In order to measure the distance of an inaccessible object, the length of a base line must be previously determined, and from the different positions which the object seems to occupy when seen from the two ex-

tremities of the base line, its distance can be readily found, as in the triangle which has the object for its vertex, the base and angles next the base are known. In this way the moon's distance can be accurately found.

Let C, in Fig. 1, be the centre of the earth, and A, B,

Fig. 1.



two stations on the earth, under the same meridian, and distant from each other by a quarter of a circumference, or 90 degrees. Let M be the centre of the moon when it is on the meridian of both stations, and, for simplicity, suppose M is in the direction of C B, or that the moon is in the zenith of the observer at B. If either the angle at M or that at A can be measured, then in the triangle A C M two angles are known, as well as the side A C which is the earth's radius, whence C M the distance of the moon from the centre of the earth can be calculated. The angle C A M might be found by measuring the zenith distance of the moon at A, that is the angle Z A M; but as the moon is then in the horizon, this angle would have to be corrected for atmospheric refraction, about which, especially near the horizon,

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there is always a considerable amount of uncertainty. The angle is practically much better determined by observing what stars, T and S, are seen in the same direction as the moon from the two stations, and measuring the angle between the two stars. This angle, whether seen at the moon or the earth, is the same, as the distance C M is inappreciable compared with the distance of the stars. In this way the troublesome element of refraction is almost eliminated, as T and S are nearly equally affected by it. If no stars are seen exactly at T and S, stars near those places are selected, and the differences of the positions from the direction of M are found. As the result of numerous observations of this kind, the angle A M C has been found to amount to very nearly a degree, or more correctly 57′ 2·3″. If we imagine a circle described round M as centre, with M C as radius, it is easy to see that A C is very nearly the three hundred and sixtieth part of the circumference, and as the diameter is, roughly speaking, about a third part of the circumference, the distance M C must be nearly sixty times the earth's radius. This rough calculation gives a curiously exact result, the small errors made compensating each other in great measure, as the true number is $60\frac{1}{4}$.

The angular displacement of an object caused by a change in the position from which it is viewed, is called its *parallax*. To reduce observations made on celestial bodies at the surface of the earth to its centre, the correction for parallax must be applied, and the magnitude of this correction will depend both on the distance of the object and the angle which its direction makes with that radius of the earth drawn to the observing

station. In other words, the parallax of a celestial body for any given station on the earth's surface is the angle under which an observer on the distant body would see the earth's radius drawn to that station. The greatest parallax will be when this radius is viewed perpendicularly. And as the body would then be in the horizon of the observer, this greatest value is called the *horizontal* parallax. As the earth's radii are not all of equal length, the equatorial radii being greatest, it follows that the horizontal *equatorial* parallax will be the absolutely greatest value of the angle for any given object; but since the figure of the earth is well known, any one of these values can be found when another is given.

It is evident that the parallax of a star will diminish as the distance increases, and as the moon, our nearest neighbour, has a horizontal parallax of less than a degree, the sun, planets, and fixed stars must have parallaxes difficult to measure exactly. Not only does no change of position on the earth's surface make the slightest change in the apparent position of any fixed star, but even when the earth changes its position in space by half a year's motion in its annual orbit, still there is no change in all but a very few cases, and in them, the *annual* parallax, as it is termed, amounts to but a fraction of a second, whence it follows that the diameter of the earth's orbit is a mere point in comparison with the distance of the fixed stars.

The determination of the sun's distance has always been deemed one of the fundamental problems in astronomy, and it is interesting to note the various opinions that have from time to time been held on this

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subject. With the rude instruments of the Babylonian and the early Greek astronomers it was impossible to measure to within a single degree, and consequently their opinions were the result, more of speculation than of observation. Their instruments were the *πόλος* and the *γνώμων*, both modifications of the common sun-dial. The former consisted of a hollow hemisphere, the sides of which, and sometimes a point in the centre, cast the shadow on the concave interior, which was at first plain, but afterwards marked with circles parallel to the rim and semi-circles crossing these. In the latter, a pointer or style, sometimes vertical, sometimes directed to the pole star, threw its shadow on a flat surface, marked with lines to divide the interval from sunrise to sunset into twelve equal parts. Herodotus, in Book II. chapter 109, says *πόλον μὲν γὰρ καὶ γνώμονα καὶ τὰ δυώδεκα μέρεα τῆς ἡμέρης παρὰ Βαβυλωνίων ἔμαθον οἱ Ἕλληνες.* But the Babylonians contented themselves with rough observations, noting positions by quarter diameters of the moon and times to the nearest quarter of an hour.

Thales, the wise man of Miletus, who lived from 630 to 540 B.C., is the earliest Greek astronomer of whose doctrines we have clear and well authenticated evidence. He first taught the true nature of eclipses, and is said by Herodotus* to have foretold the year in which an eclipse of the sun would take place. This eclipse has been identified by the present Astronomer

* Book I, chapter 74. *τὴν δὲ μεταλλαγὴν ταύτην τῆς ἡμέρης Θαλῆς ὁ Μιλήσιος τοῖσι Ἴωσι προηγόρευσε ἔσεσθαι, οὖρον προθέμενος ἐνιαυτὸν τοῦτον ἐν τῷ δὴ καὶ ἐγένετο ἡ μεταβολή.*

Royal as the one which took place on the 28th of May, 584 B.C., and which was total over Cilicia in Asia Minor. Thales held that the sun was 720 times as large as the moon, an estimate which is too large in the ratio of 5 to 9 if the comparison is between the diameters, and 200 times too small if between the surfaces.

Anaximander, also of Miletus, who was born about twenty years after Thales, held that the sun consisted of a central luminous part, of the same size as the earth, and an outer opaque ring, whose exterior circumference was twenty-eight times that of the earth; that the dark ring, like a chariot, gave motion to the sun, and that an eclipse took place whenever the dark part came between us and the central part.

Heraclitus of Ephesus, who flourished about 500 B.C., taught that the sun was no larger than it seemed, viz., about the width of a man's foot, and that it was bowl-shaped, the convexity being luminous and the concavity dark. The system of Pythagoras, who was contemporary with Heraclitus, as related by Philolaus, one of his disciples, who lived about a hundred years after him, deserves mention on account of its originality and boldness; but it is impossible to say from the account of Philolaus how much is due to the great master himself and how much to some of his followers. In this system, the earth is deprived, for the first time, of its dignified position as the fixed centre of the universe, and made to revolve round a central fire. Next to the earth is the moon, then the sun, the five planets, and, last of all, the sphere of the fixed stars, all revolving round the same central fire. An imaginary body,

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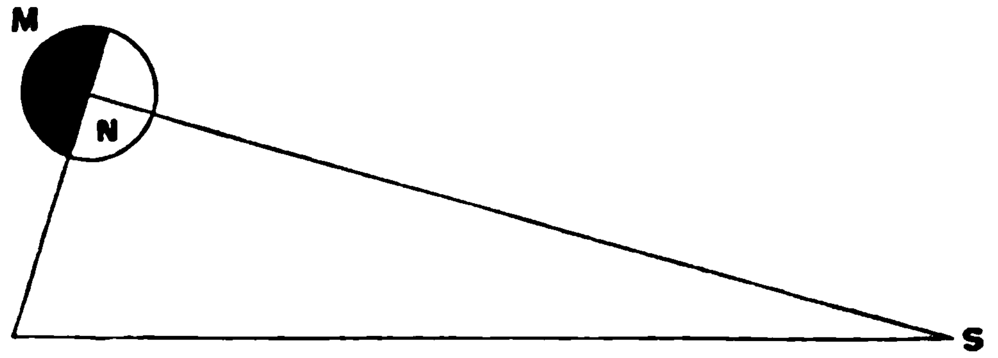
called the *antichthon*, was placed between the earth and the central fire, probably, as Aristotle says, to make up the number of orbits to ten. The distances from the centre were—to the antichthon, 3; to the earth, 9; the moon, 27; the sun, 81; and so on. This scheme was based entirely upon abstract considerations, and utterly fails to account for the observed phenomena.

Eudoxus of Cnidos, who flourished about 370 years B.C., first imported scientific accuracy into astronomy. He built an observatory on a hill, that he might have a better view of the stars, and observed their positions at rising and setting compared with definite points of the zodiac. He calculated the sun's distance to be nine times that of the moon; but so uncertain was he on this point, and so enthusiastic in his astronomical studies, that he declared he would willingly be consumed, like Phaethon, if he might first approach so near the sun that he might be able to discover its size and figure.

Aristarchus of Samos, who was the first to propound a theory of the universe similar to the Copernican, lived about a hundred years after Eudoxus. He proposed a most ingenious method to find the sun's distance, in which the distance of the moon was taken as the base line, and his method remained for many centuries the only one available. He remarked that when the moon was half full (διχότομος σελήνη), the earth is on the plane of the circle which divides the light from the dark half. And the line joining the centres of the sun and moon is perpendicular to this plane. In the diagram, Fig. 2, let E and S be the centres of the earth and sun,

M the moon *dichotomotized*, and N its centre. The angle ENS is a right angle. If the angle NES, the angular distance between the sun and moon, be observed, then the line ES can be expressed in terms of EN. Aristarchus found the angle NES to be 87 degrees, and therefore the angle at S three degrees; but as trigonometry was unknown in his time, he could only solve the triangle by roundabout geometrical approximations. He thus found the sun's distance was more than 18 times, but less than 20 times, that of the moon—a result which has the merit of being the first that was grounded on genuine observation and calculation, and

Fig. 2.



which was for a long time accepted as being near the truth. The error lies in the measurement of the angle, which should have been 89° 51′, and therefore the angle at S, instead of being 3° or 180′, should have been 9′, consequently the sun's calculated distance is about the twentieth of its true distance. With the refined instruments of the present day, this method cannot be applied with even moderate accuracy, as, owing to the extreme roughness and irregularity of the moon's surface, it is impossible to say at what time it is exactly half full.

Eratosthenes, a Greek astronomer, who observed at Alexandria about 200 years B.C., is famous for his

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determination of the size of the earth by a method identical in principle with that still used, and has the merit of taking the first step towards the correct measurement of celestial distances. Syene (in Upper Egypt) and Alexandria were known to be nearly on the same meridian, and at the former place the sun at noon of the longest day was in the zenith, as the vertical gnomon of the sun-dial cast no shadow. This is equivalent to saying that Syene is on the Tropic of Cancer, which is nearly correct. At Alexandria on the longest day the sun was found to be distant from the zenith by the fiftieth part of a whole circumference: and Eratosthenes concluded that the distance between these two towns was the fiftieth part of the earth's circumference. This distance had been previously measured by the royal geographers, and found to be 5000 stadia, thus making the circumference 250,000 stadia. He then found the moon's distance 780,000 stadia, and the diameter of the sun 27 times greater than that of the earth, results which are too small, the first three, and the second four, times.

Hipparchus, born at Nicæa, in Bithynia, about 200 years B.C., was perhaps the greatest astronomer of antiquity. He designed and constructed the astrolabe, for measuring angular distances along and at right angles to both the celestial equator and ecliptic. He was an assiduous and careful observer, and he was besides a skilful computer. He had constructed for himself, or at least was in possession of, a table corresponding to our table of natural sines of angles, and he was acquainted with both plane and spherical trigonometry. His astrolabe, which was identical in principle

[illegible] theodolite, without the telescope and [illegible] th the horizontal circle in the plane of [illegible] not accurate enough to enable him to [illegible] lar parallax; but assuming the value [illegible] Aristarchus, he calculated, from eclipses of [illegible] parallax of the moon, which he made [illegible] very close approximation to the true [illegible]

[illegible] maeus, whose system of astronomy [illegible] till the time of Copernicus, was born at [illegible] Egypt, about the year A.D. 100. He [illegible] so diligent and accurate an observer as Hipparchus, but his great merit consists in his [illegible] and reduced to order the observations [illegible] and in his extension and improvement [illegible] planetary motions. [illegible] principal work [illegible] Μαθηματικὴ Σύνταξις, but better known [illegible] Almagest [illegible]

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its horizontal parallax is 2′ 51″, which we know is about 19 times too large. The error arises from the too great value assigned to the radius of the earth's shadow: and a small error made in this element influences the resulting parallax in a great degree.

The question of the sun's distance remained as it had left Ptolemy's hands till the beginning of the seventeenth century, when the accurate observations of Tycho Brahé enabled Kepler to calculate the parallax of Mars, and thence that of the sun. The instruments with which Tycho observed were larger, and more correctly divided, than any that had ever been used before his time. His copper mural quadrant had a radius of nine feet, the limb was divided to every minute, and each minute could be subdivided into ten seconds by a diagonal scale. This instrument was placed exactly in the plane of the meridian, and firmly fastened to a solid wall. In using it, the line of sight was directed to a star by turning an arm, moveable about the centre until a pin at the centre and another at the extremity of the arm were seen in the same line with the star. As it was impossible to direct this arm with perfect precision, the observations could not be depended on to the fraction of a minute, even allowing that the divisions were accurately placed. Tycho was the first astronomer who corrected his observations for refraction, and though his table of refractions was inexact, this was a great step in advance of all his predecessors. Some of Tycho's observations of Mars were when the planet was apparently stationary, and when therefore any angular displacement from a fixed star could only arise from the effect of parallax. Now,

although the actual distances of the planets from the sun were not well known, the ratios of the mean distances were perfectly known, as by Kepler's third law the cubes of the distances have the same ratio as the squares of the periods of revolution; and these times were known to within a very few seconds. As the parallax of Mars is too small to be derived from observations which are not certain to half a minute, Kepler distrusted his value of the solar parallax, and contented himself with saying that it was certainly not more than a minute, and in all probability fell considerably short of the amount.

The invention of the telescope, the addition to it soon afterwards of the micrometer, for measuring small distances, the application of the pendulum to regulate the motion of clocks, and the establishment of public observatories in several countries in Europe about this time, contributed materially to advance the progress of practical astronomy in all its branches; while the application of algebra to geometry, the invention of the differential and integral calculus, and the discovery of the law of gravitation by Newton, laid the secure basis of physical astronomy. Picard, in 1667, was the first who applied the telescope and micrometer to divided instruments; and now for the first time we begin to get trustworthy measures of the sun's distance. Domenico Cassini, the first of the illustrious family of astronomers who, for four successive generations, adorned the annals of French science, was appointed in 1669 to the directorship of the Paris Observatory, and three years afterwards an expedition was organised by the Academy of Sciences, having for its main object the deter-

mination of the sun's distance. The method devised by Cassini was to make simultaneous observations of the planet Mars when in opposition, and therefore nearest to the earth, from two places considerably distant from each other. Accordingly Richer was sent to Cayenne, in South America, while Cassini, Roemer, and Picard made observations on the planet at different places in France. By a comparison of a great many observations, the parallax of Mars was found to be 25½ seconds, whence that of the sun, by Kepler's law, must be 9½. Of this result, which is surprisingly near the truth, Delambre, a most severe and impartial historian, says, in his *Histoire de l'Astronomie moderne*, vol. ii. page 741 : ". . . . quand on considère le peu d'accord des observations, on est forcé d'avouer qu'il y a un peu de bonheur dans ce résultat, comme dans tant d'autres, et il ne prouve que l'avantage qu'on trouve à multiplier les observations pour en prendre la moyenne."

In 1751 Lacaille was sent to the Cape of Good Hope to make similar observations of Mars. On comparing his own observations with some made by Bradley at the Greenwich Observatory and others made by astronomers in different parts of Europe, he found, as a mean of 27 different determinations, 26·8 seconds for the planet's parallax and 10·2 seconds for the sun's at its mean distance.

In 1836 Professor Henderson made a similar comparison of observations, which he had made at the Cape of Good Hope in 1832, with others made at the observatories of Greenwich, Cambridge, and Altona. The number of observations used was not very great,

and the results of the comparison of the Cape observations with those of the three European stations were slightly discordant; but the mean of the three results gave 9·028 seconds for the solar parallax. The opposition of 1832 was not so favourable as that of 1751, as the parallax of Mars, the angle to be directly measured, was over 26 seconds in the latter year, whereas it was only 17·11 seconds in the former, and any error made in the measurement of the angle is a larger proportional part of the less than of the greater.

In the year 1676 Edmund Halley proceeded to St. Helena to make a catalogue of the Southern stars; but the cloudy skies and frequent rains interfered much with the success of his scheme. While there he witnessed a passage of Mercury across the disc of the sun, and on afterwards comparing his observation with a similar one made at Avignon, he obtained 45 seconds for the sun's parallax. He had no confidence in this result, as the Avignon observations were doubtful, and the parallax of Mercury was too small to be accurately measured. In 1716 he published a paper in the *Philosophical Transactions*, pointing out the greater advantage which would be derived from observing transits of Venus, as the angle to be measured in this case is nearly three times the sun's parallax, and earnestly imploring astronomers, as the phenomena happened so rarely, not to neglect a valuable opportunity of determining the fundamental element of our solar system. The idea was not new, as Kepler, in 1627, had completed his planetary tables, ascertained from them that Venus would cross the sun's disc on December 6, 1631, a phenomenon that would not

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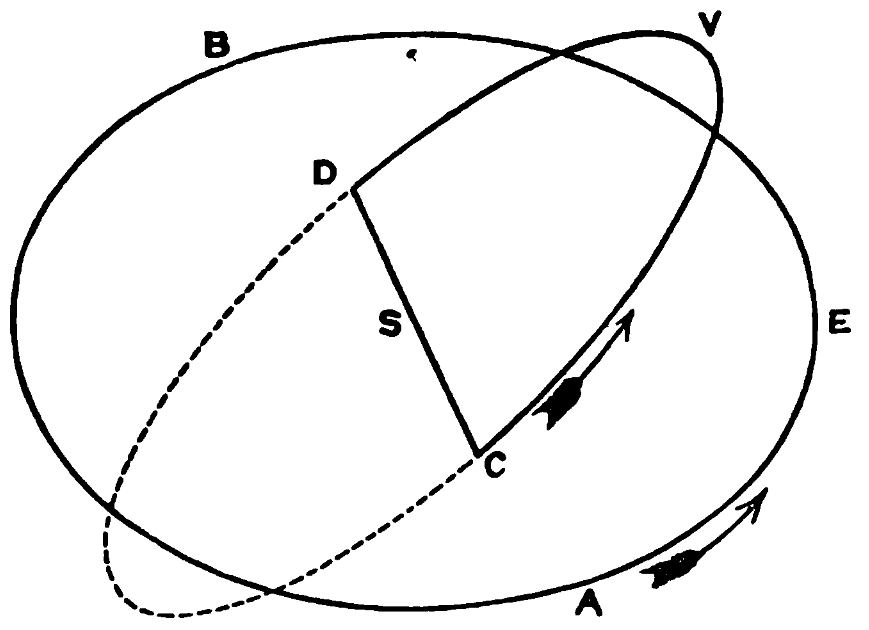
occur again for 235 years, and expressed his belief that astronomers would learn from this occurrence things which they could not otherwise learn. Again, in 1663, James Gregory, the inventor of the telescope which bears his name, published a book in London, in which he expressly states that observations of Venus or Mercury, when on the sun's disc, might furnish means of finding the sun's parallax. Whether Halley conceived the idea independently of his predecessors or not, he deserves full credit for so pointedly directing the attention of astronomers to it, and for using his great authority on astronomical matters to induce European Governments to fit out expeditions for the proper observation of the phenomena.

Transits of Venus can only happen when she is in the same straight line with the earth and some part of the sun's disc; but as the plane in which Venus moves is inclined 3° 23′ to that in which the earth moves, it is clear that these conjunctions will not happen often. Let AEB, CVD, in Fig. 3, represent the orbits of the earth and Venus respectively, a spectator on the earth will always see Venus above or below the sun's centre, unless the planet should happen to be in the plane of AEB, and therefore ascending through it at C, or descending through it at D. If the earth should

Fig. 3.



happen to be at A when Venus is in or very near her ascending node C, or at B when she is near her descending node D, she will be seen projected as a dark spot on the sun's face, her unillumined half being then turned towards us. Kepler's transit of December 6, 1631, took place near the ascending node, but after Venus had actually passed to the upper or northern side of the earth's orbit, consequently she would have been seen crossing the sun's face above his centre. Although preparations were made to observe this transit, it was not witnessed in Europe, as it took place after the sun had set for all parts of the Continent.

Eight revolutions of the earth are completed in very little more time than thirteen of Venus and, more exactly, 235 of the earth's occupy a little less time than 382 of Venus. Transits will thus take place at the same node at intervals of 8 and 235 years; and in December 1639 the second predicted transit took place; but this time Venus was on the under side of the earth's orbit, and crossed the sun below his centre. Kepler's tables were not accurate enough to enable him to predict this transit. This honour was reserved for a young Englishman, Horrox, who had also the good fortune to witness the transit; but owing to the near approach of sunset he was unable to complete his observations. The date of the next transit at the ascending node is found by adding 235 to 1639, and is thus in December 1874, and this will be followed by another in December 1882, after which there will again be none for 235 years.

Transits at the descending node took place in June 1761 and 1769. It was to these that Halley

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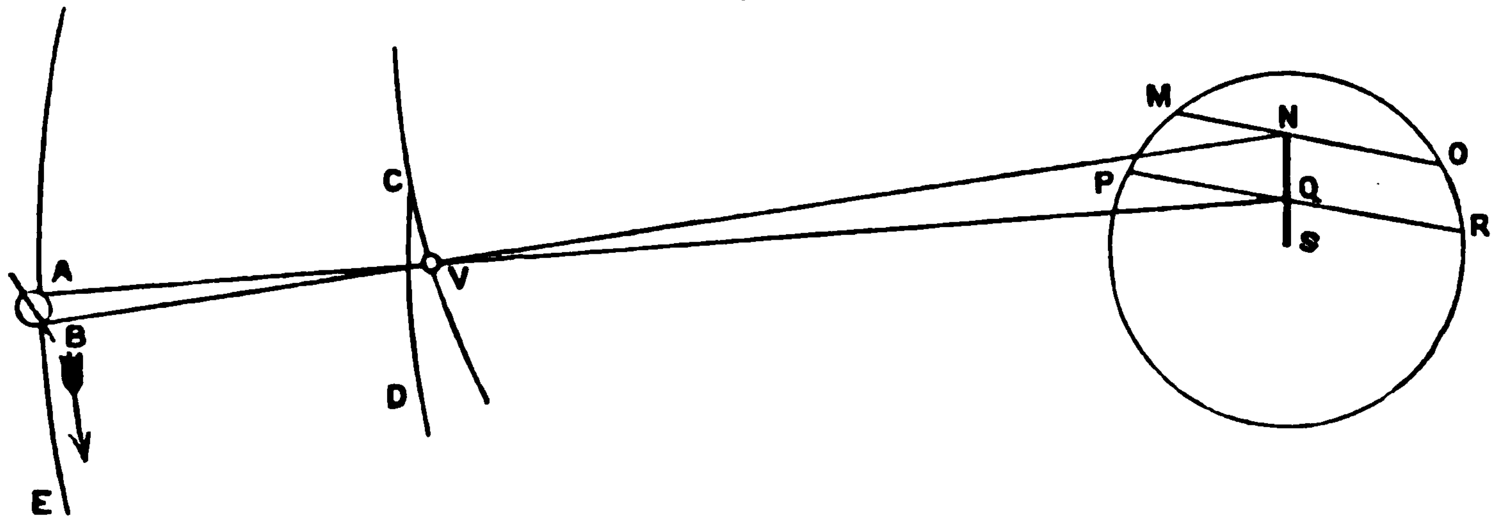
specially directed the attention of astronomers. That of 1761 was not well observed, and the results derived from it proved very unsatisfactory. It was different in the case of the celebrated transit of June 3, 1769. Most of the European Powers sent out well-equipped expeditions to many of the best stations that could be selected, and the numerous observations made have been satisfactorily discussed by many able astronomers with a wonderful agreement in the final results. The principle of finding the sun's parallax from transits of Venus and the mode of making the observations is very simple, though the practical details are complicated enough. Let A E, C V, in Fig. 4, be portions of the orbits

Fig. 4.



of the earth and Venus, C the ascending node, C D the projection of the orbit of Venus on the plane of the earth's orbit, and S the centre of the sun's disc M O R P. A spectator at A, in a high north latitude, will see Venus as a dark spot traversing the sun's face from P to R, the angular motion of Venus in her orbit being greater than that of the earth in the proportion of 13 to 8. Another spectator at B, in a high south latitude, will see the planet traverse a different line, M O, higher up on the sun's disc, and manifestly the distance between these lines, that is the distance N Q, will depend, first, on

the distance A B; and, secondly, on the proportion which A V bears to V Q. The first distance is known whatever be the points A and B, as the earth's form and size are well known; and the second ratio is known by Kepler's law. This ratio is nearly 18 to 7, that is nearly $2\frac{1}{2}$ to 1, consequently the distance N Q is about $2\frac{1}{2}$ times A B. And if A B is a diameter of the earth perpendicular to the line A S, then N Q is nearly 20,000 miles. Suppose now that Venus could, at the same instant of absolute time, leave on the sun's face a permanent mark of her position as seen from A and B, on looking at those two marks from any other place, or at any other time, we should always know that they were 20,000 miles apart, and by finding what proportion this distance bore to the whole diameter, we could find this diameter in miles. Or if we measure the angle which the distance between the two marks subtends at the earth, then one-fifth part of this angle will be the angle under which the earth's radius is seen at the sun, or the solar parallax. Thus, by multiplying the angle to be measured by 5, any small error made in determining the angle introduces into the result an error of one-fifth of that which would be made by the direct measurement of the angle itself.

Of course, Venus leaves no trace of her position on the sun's surface; but it is possible to photograph the transit from two stations at the same absolute time, and then to measure the distance between the spots on the negatives. If a single pair of good negatives could be taken at the same instant, and if the positions of the two stations were perfectly known, the sun's parallax would be completely determined, and accordingly pho-

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tography will be much employed in the transit of 1874. The method of observation which Halley recommended was to note the exact instant when Venus touched the edge of the sun externally and internally both at ingress and egress. The mean of the two times at ingress, subtracted from the mean of the two times at egress, gives the time that the centre of Venus was seen at the one station on the sun's disc, and therefore gives a measure of the line M O. Similar observations at the other station give a measure of P R, and therefore the difference of the lines, which is entirely due to parallax, is known. Assuming a certain value for the sun's distance, the time can be calculated during which the transit would be seen at both stations, and if the calculated difference coincides with that observed, the assumed distance is the correct one. If not, the assumed distance must be altered till the two results agree.

In the actual transits the problem is much more intricate, as the earth is constantly rotating on its axis, the stations A and B are not diametrically opposite, and the line joining them is not perpendicular to the line from the earth to the sun. It is evident that the rotation of the earth might be utilised to increase the observed difference of duration of the transit, for if at the instant of first contact a plane be conceived touching the sun's limb at the point of contact, and passing through the earth's centre, then, at all stations on the circle in which this plane cuts the earth, the transit will commence at the same time. For any station on the left of the plane (with reference to spectator at the earth's centre, looking towards the

sun), the transit will commence sooner, the displacement having thrown Venus upon the sun's disc; and for stations on the right it will commence and end later. If we can choose a station such that at the beginning of the transit, as seen from the earth's centre, it was on the left of the plane, but by the rotation of the earth, it was at the end of the transit, *i.e.* about six hours afterwards, on the right of the plane, the total duration is increased both by the acceleration of ingress and the retardation of egress. A second station may be chosen, so that the duration is diminished by a retarded ingress and an accelerated egress, and thus the observed difference of durations is greatly increased. Wardhoe (in the North of Lapland) and Otaheite were the two stations used on the last transit at which the observed difference of durations was greatest. The two stations on the earth most distant from the plane just referred to, would be well suited for determining the sun's parallax from a single observation at each. Suppose the time of first external contact only to be carefully observed, the difference of these two times is a direct consequence of parallax. A method substantially the same as this was first proposed by Delisle.

In a discussion of many of the observations of the last transit, in his *Astronomie théorique et pratique*, Delambre finds the solar parallax to be contained between the limits 8·5 and 8·7 seconds. Professor Encke published in 1824 an elaborate treatise, *Der Venusdurchgang von* 1769, in which he found, by a comparison of all the observations, the sun's parallax to be 8·5776 seconds. In an interesting paper, published in the *Memoirs of the Royal Astronomical Society*,

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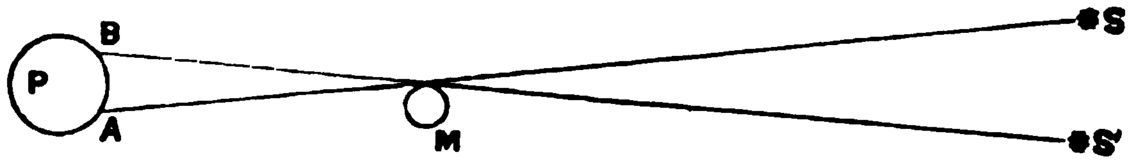
vol. v., J. de Ferrer discusses a great many observations, obtains the final result 8·577 seconds, and examines various values deduced by different astronomers. A striking confirmation of these concordant results was afforded by a discovery of Laplace, published in his *Mécanique céleste*, towards the end of last century. In solving the differential equations of the moon's motion and carrying the approximations to the third order, a term occurs in the expression for the moon's longitude, of which the argument is the angular distance between the sun and moon, and the coefficient is the ratio of the moon's distance from the earth to the sun's multiplied by a constant factor. This expression or inequality, as it is termed in astronomy, attains its greatest value when the angular distance between the sun and moon is 90°; and this value has been found by observation to amount to about 122 seconds. Comparing the theoretical with the observed value of the parallactic inequality, the ratio of the lunar to the solar parallax is determined, and as the former is well known, the latter becomes also known. In this way Laplace found the solar parallax to be 8·632 seconds. The value 8·6 seconds was generally received as being correct to probably within a tenth of a second, although some astronomers accepted it only as provisional, and were patiently waiting till improved methods and better instruments could be applied to the transits of 1874 and 1882. In 1854 Hansen had nearly completed his Lunar Tables, and in a letter to the Astronomer Royal on the construction of his tables, dated November 3, 1854, he says: "The coefficient of the parallactic equation is 125·705 seconds, an amount

exceeding any which has hitherto been assigned, and which indicates a greater value of the sun's parallax than has been deduced from the observations of the transits of Venus. The Greenwich observations, exclusive of any others, assign the foregoing value of the parallactic inequality, and the Dorpat observations nearly the same value. I cannot therefore alter it." This, the first indication of the necessity of increasing the sun's parallax, and therefore of diminishing his distance, was soon followed up by others.

On the 8th of May 1857 the Astronomer Royal proposed to the Astronomical Society a method of making observations for parallax, not applicable to Venus, but applicable to Mars; namely, by observing the displacement of Mars in right ascension when he is far east of the meridian and far west of the meridian, as seen at a single observatory. Thus, in Fig. 5, let the

Fig. 5.



pole P of the earth be turned towards the eye, and by the diurnal rotation of the earth, let an observatory A be carried to B. At the first position, Mars denoted by M is seen in contact with a star S, or at a small distance from it, while at the second it is at a small distance from another star S'. These observations, as in the case of the moon, give us the means of determining the angle at M, and therefore the distance of Mars and of the sun. By taking an observatory near the equator, a base line A B can be obtained considerably greater than the best that can be got by meridional combination of any two

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rvatories; and though both the earth and Mars are ing, yet the effects of these motions can be exactly ılated. Mr. Airy adds that "this method is attended no expense whatever; the observations which are ɔared are made with the same telescope and by same observer; there is none of the tediousness, vearying correspondence, or the doubt, which are ›arable from observations requiring distant co-ation; and the observer is supported by the feeling his own unassisted observations will give a perfect :m of means for deciding one of the most im-ınt questions in astronomy." He further points :hat the oppositions of Mars in 1860 and 1862 are nost favourable for these observations, on account .e small distance of the planet from the earth.

ı 1861 M. Le Verrier, Director of the Paris ɜrvatory, made a re-determination of the orbits Iercury, Venus, and Mars, and found that it was ›ssible to reconcile their motions with observation, ming the generally received value of the sun's ınce, without an inadmissible increase of the plane- masses. An increase of the mass of the earth by ıt one-tenth part would destroy nearly all the dis-ancies between theory and observation; but this ld disturb the relation between the known force of ity at the surface of the earth, the mass of the ı, and the sun's distance, unless this latter were nished by about one-thirtieth part. He therefore l upon 8·93 seconds as the most probable value of solar parallax. This conclusion was strengthened calculation from observation of the coefficient of unar inequality in the earth's longitude which he

had made three years beforehand, and from which he obtained almost the identical number 8·95 seconds.

In the meanwhile, M. Foucault was engaged in trying to find by experiment the actual velocity of light, by an arrangement consisting of a series of reflecting mirrors, one of which was made to revolve uniformly with a very great velocity; and as the result of many careful experiments he was forced to the conclusion that the velocity of light, as deduced originally from the eclipses of Jupiter's satellites, must be diminished by about its thirtieth part. Now, by observing the apparent displacement of the stars by aberration, the maximum displacement had been previously found, without any reference to the velocity of light, to amount to 20·445 seconds; and this angle must therefore be that which the distance traversed by the earth in its orbit in a second, subtends at a distance equal to that which light travels over in a second. If then the velocity of light be diminished by a thirtieth part, so must that of the earth in its annual orbit; but as the time, or the length of the year, is well known, the radius of the orbit, that is the sun's distance, must be similarly diminished. The solar parallax actually deduced by M. Foucault was 8·86 seconds.

The opposition of Mars in 1860 was unfortunately not observed by astronomers, their attention having been occupied with a total eclipse of the sun, which took place in that year; but the opposition of 1862 was well observed at Greenwich, Pulkova, Cape of Good Hope, Williamstown (in Victoria, New South Wales), and at some other places. The method adopted was the observation of differences of North polar

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distance between Mars and comparison-stars near the meridian, a list of which had been previously drawn up by Dr. Winnecke, of Pulkova. An able discussion of these observations is given by Mr. Stone, lately first assistant at the Royal Observatory, Greenwich, in volume xxxiii. of the *Memoirs of the Royal Astronomical Society.* By combining 27 of the Greenwich and Cape observations, he finds 8·918 seconds for the solar parallax, with a probable error of ±·042 seconds, while 21 of the Greenwich and Williamstown observations give 8·930 seconds, with a probable error of ±·035 seconds. A final combination of the two sets gives 8·943 seconds, with a probable error of ±·031 seconds. Mr Stone adds, "I do not consider the number of observations here discussed sufficiently great to allow of much importance being attached to the second decimal place; but I think there can be little doubt about the sun's mean horizontal parallax being as great as 8·9 seconds; and the value 8·943 seconds is that which has the greatest probability in its favour, so far as these observations are concerned."

Dr. Winnecke, in the *Astronomische Nachrichten,* No. 1409, gives the results of a comparison of thirteen observations made at Pulkova with those made at Santiago in Chili, and finds the resulting parallax 8·964 seconds.

The near agreement of the numbers obtained by all these different methods is a strong proof of their accuracy, while their discordance by about three-tenths of a second from the result of the last transit of Venus, gave rise to considerable anxiety and some doubt. This induced Mr. Stone to enter into a careful re-discussion

of all the observations of the transit, and his paper was published in 1868 in the supplementary number of the *Monthly Notices of the Royal Astronomical Society*. He finds that in consequence of the peculiar appearances presented when Venus touches the sun's limb internally, different observers noted the times of different phases. At ingress, when the internal contact seemed just about to take place, suddenly a dark ligament, as in Fig. 6, appeared to join the limbs of the planet and the sun, which ligament or *black drop* continued for several seconds, even while the disc of the planet seemed fairly on the sun's face. Just before the black drop disappeared, the planet had a pear-shaped form, as in Fig. 7. The same phases were also observed at the interior contact at egress, and at the external contact the planet did not recover its circular form till some seconds after it was clear of the sun's limb. By strictly interpreting the language employed by the observers, and inferring whether the phenomenon noted by them referred to an apparent or a real contact, Mr. Stone has deduced, from the internal contacts of the transit, the value of 8·91 seconds for the solar parallax, with a probable error of ·02 seconds. This result abundantly confirmed those previously obtained, and left no doubt in the minds of astronomers that the sun's distance must be diminished from 95 to 91 millions of miles. In addition to this signal service rendered to astronomy, Mr. Stone's paper proves how completely the obtained value of the sun's parallax depends upon so slight a

Fig. 6.

Fig. 7.

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cause as the misconception of obvious words about real and apparent contacts, and thus it has prepared astronomers for the proper observations of the transits of 1874 and 1882. Already experiments have been conducted at Greenwich with a working model, in which a black disc is moved by clockwork. With this artificial planet, the *black drop* is also very evident, and it is hoped that by numerous observations by different observers with different telescopes, it will be found in what proportion the phenomenon is due to the aperture of the telescope used, and to the observer himself.

The coming transits of Venus are looked forward to with intense interest, not only as there will not be another till the year 2004, but also as they will allay the slight suspicions that still haunt the public mind on the question of the sun's distance. Already the American Government has selected eight stations for observations, the French five, the German four, the Russian nineteen, and the English eight, all at widely different distances, and chosen after anxious consideration as being the most suitable. These forty-four expeditions will consist of all the ablest astronomers of the time, and as they will be furnished with the most improved modern instruments, there is no doubt that before twelve months have elapsed the grand problem of the sun's distance will be definitively settled to within its hundredth part, and that all of the problem that will remain for future generations will be to push the approximation to more and more decimal places, as their methods and instruments improve.

THOS. H. CORE.

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THE LIMITS OF OUR KNOWLEDGE OF THE EARTH.

1. OUR knowledge of the earth has gradually been widened and extended by the united labours of many eminent men, until, at the present time, geology claims a rank among the sciences not inferior to that enjoyed by any of her sisters. The present order of things has been proved to have sprung out of antecedent conditions, which form a continuous chain far away into the remote past, each link being connected most closely with its predecessor and its successor, and yet none ever being a mere repetition of what went before. The causes at work at the present time on the surface of the earth are shown to have operated also in past time. In preceding ages the rains and the rivers carved out the valleys and shaped the mountains, as they do now, and glaciers crowned the higher regions and carried down into the lower grounds their freight of mud and rock. The volcanoes of olden times differed not materially from those which are now active, and the Trappean rocks of Derbyshire, of Edinburgh, and of the north of Ireland, or of Auvergne, are strictly analogous to the lava-flows of Vesuvius or Etna. The sandstones, conglomerates, clays, and limestones which constitute the stratified rocks, in thickness not less than

from eight to ten miles, have been either torn away from ancient continents, or are the work of coral zoophytes, foraminifera, various kinds of shell-fish, and other organisms which have the faculty of secreting carbonate of lime in their tissues, and are to be seen now in process of formation on every coast-line and at the bottom of every sea. And just as now there are certain areas on the surface of the earth which are being elevated while others are depressed,—as, for example, in the well-known case of the Scandinavian peninsula—so were there such in old times. Similar depressions account for the enormous thickness of the ancient strata; and like elevations explain the fact that the present land is mostly composed of subaqueous rocks. Or again, if we appeal to the history of life as revealed in the rocks, we are guided strictly by our experience of that which is now to be found on the surface of the earth. The present distribution of plants and animals affords the clue for the investigation of the ancient climate and of the conditions under which each group of beings flourished. The history, for example, of the submerged forest surrounding the shores of Britain, with the stumps of the trees rooted in the soil on which they grew, imbedded in vegetable matter and covered by marine sand or estuarine mud, explains the mode in which a seam of coal was formed; the soil below representing the under clay, the sand and mud above the sandstone and shale, the stumps the erect sigillariæ and lepidodendra. From this close analogy it would follow that the carboniferous vegetation grew not very far from the borders of the sea or estuary, and that it was subject to depressions from

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time to time. And in like manner, the presence of the Axis and Rusa deer, in the Pleiocene deposits of France and Italy, implies that then the climate was somewhat similar to that of the regions of south-eastern Asia, in which they now live.

For the accumulation of enormous thicknesses of rock a long lapse of ages is necessary, as well as for those changes in the organic world which enable us to classify the stratified rocks and to use the fossils as the figures on the dial of a clock; because accumulations of sediment are now slowly formed, and organic change, without the intervention of man, is so slow as to be incapable of proof. If then the infinity of space has been revealed to us by the astronomer, so has the enormous duration of time been demonstrated by the geologist.

By the applications of principles such as these, the ancient history of the earth has been interpreted by an appeal to existing forces, without any interference of a miraculous power with the operation of known laws. Have these forces varied in intensity? Are the enormous revolutions which the geologist recognises in the rocks to be measured by the almost imperceptible rate of change observed in existing nature? Or have we, as Professor Huxley happily puts it, an "unlimited bank of force" to draw upon as well as "an unlimited bank of time?" The researches of Grove, Thomson, Mallet, and Mayer enable us to give no hesitating answer to these questions, which lie at the very root of geological theory.

2. The leaders of the Uniformitarian school of geological thought—Hutton, Playfair, and Lyell—hold that in the lapse of time represented by the

vast thickness of the stratified rocks, the terrestrial forces were not felt to a greater degree than in the present order of nature, and that no evidence of a beginning of things, and no prospect of the earth coming to an end, are offered by any physical line of enquiry. They also agree in practically ignoring the speculation of the cosmogonists, as being far removed out of the reach of any scientific test. The progress of modern discovery, however, in physics, and especially of that which relates to the constitution of extra-terrestrial bodies, enable us to investigate both the earth's past and its future, by the same inductive method as that by which geology became a science—by a comparison of the earth with its fellow wanderers in space. It will be necessary, before any argument can hold good from the one to the other, to prove that all are knit together by an intimate bond of union. I will take the meteorites first.

3. The meteorites* which fall to the earth, giving rise to the phenomena of shooting stars in their passage

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* The character of meteorites may be gathered from this abstract of M. Daubrée's classification :—

A. Siderites. Meteorites containing metallic iron :
- I. Holosiderites composed of metallic iron without stony materials.
- II. Syssiderites, containing iron and stony materials; the iron being in a continuous mass, and the stony materials being disseminated through it.
- III. Sporadosiderites. The iron present in disseminated grains.

B. Asiderites. Meteorites without metallic iron :
- IV. Asiderites.

—*Expériences synthétiques relatives aux Météorites*, par M. A. Daubrée Paris, 1868. *Étude sur les Météorites*, par M. Stanislas Meunier, 8vo Paris, 1867.

[redacted]

through the atmosphere, are to be viewed as samples of star-dust collected in groups, which revolve in elliptical orbits round the sun, and with which, in all probability, space is more or less filled. It has long been known that they have never yielded any new elemental substance, and that they are journeying round the sun in a cold state, the thin glaze on their surfaces being due to the enormous friction which they undergo when they penetrate the earth's atmosphere. They consist of nickeliferous iron, combined with various portions of stony matter; sometimes the iron is perfectly pure and capable of being turned to the ordinary purposes of manufacture; at others, it is represented by an extremely small percentage in combination with sulphur or oxygen. The number of elemental substances discovered in the meteorites, and tabulated by MM. Daubrée and Meunier, amounts altogether to twenty-seven, or to considerably more than one-third of those known to exist in the whole mass of the earth. The following are elements comparatively common in the earth's crust.

Oxygen.	Aluminum.	Zinc.
Hydrogen.	Potassium.	Copper.
Nitrogen.	Sodium.	Arsenic.
Chlorine.	Calcium.	Phosphorus.
Iron.	Sulphur.	Antimony.
Magnesium.	Carbon.	Lead.
Silicium.	Nickel.	Tin.
Manganese.		

Of the remaining five, cobalt, chromium, titanium, lithium, and selenium, the last is alone very rare on the earth, and it is equally rare in the meteorites, having only been recognised in that which fell at Bitbourg.

If a weight of the earth's crust equal to that of a meteorite were analysed, it is improbable that it would furnish a longer list of chemical elements than the above.

4. But the meteorites have a yet stronger bond of union with the earth than that of a mere elemental identity. They present similar combinations of the elements to the number of over forty. The beautiful iridescent Labrador spar, for example, and peridot (chrysolite, olivine) are comparatively abundant, while most of the following minerals are common in the earth's crust:—

Magnetic pyrites (pyrrhotine).
Magnetite.
Chromate of iron.
Water.
Quartz.
Protochloride of iron.
Salammoniac.
Cordierite.
Grenate.
Idocrase.
Sphene.
Orthose.
Anorthite.
Enstatite.
Serpentine.
Wollastonite.
Augite.
Hornblende.
Dolomite.
Carbonate of lime.
Breunnerite.
Apatite.
Epsomite, or sulphate of magnesia.
Gypsum, or sulphate of lime.
Thenardite, or sulphate of soda.

5. To this list must be added the hydrocarbons allied to bitumen or ozokerite, which have been met with in a few meteorites, such as that of Cold Bokkewold at the Cape of Good Hope, that of Alais (Gard), Kaba in Hungary, and Orgueil in Tarne and Garonne. In the last they consisted of—

Carbon	63·45
Hydrogen	5·98
Oxygen	30·57

[redacted]

This composition, according to M. Meunier, is closely allied to that of peat or lignite. Are we therefore justified in considering that these are traces of life which once existed on the cold and lifeless meteorite? This question cannot be answered with certainty, because hydrocarbons can be produced without the intervention of organic bodies. The interesting speculation of Sir William Thomson,* that the primeval germ, or mother cell, from which all life on the earth, both animal and vegetable, may be said to have originated, was introduced from the wreck of another world, by an agency such as this, is rendered very improbable by the following two considerations. Were the fragment in question in a state of igneous fusion, like most of the meteorites have been, or were it exposed to the intense cold of space, life would infallibly be destroyed. And if it were sufficiently large to retain its own heat up to the time it arrived in our atmosphere, its force of impact on the earth would be sufficient to generate an amount of heat far greater than that which can be endured by organic bodies. The presence, therefore, of hydrocarbons in the meteorites cannot fairly be said to have any relation to the phenomena of life on this earth.

The chemical compositions presented by the meteorites so closely resemble those of the earth's crust, that M. Daubrée has succeeded in producing meteoric matter from the fusion of some of the heavier basic rocks.

6. In some cases, as M. Meunier points out, the composition of the meteorite is very nearly identical with

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* *President's Address, Brit. Assoc. Report*, 1871, pp. 104–109.

that of certain lavas, as may be seen in the following table:—

	Meteorite of Stannern (Rammelsberg).	Lava of Thurza, Icel (Gent).
Silica	48·30	49·60
Alumina	12·65	16·89
Protoxide of iron	19·32	11·92
Protoxide of manganese	0·81	—
Protoxide of cobalt	—	traces.
Magnesia	6·87	7·56
Lime	11·27	13·07
Soda	0·62	1·24
Potass	0·26	0·20
Chromate of iron	0·54	—
Protosulphuret of iron	traces	—

The differences between these two analyses are not greater than those which are very generally to be observed in the examination of two fragments of the same igneous rock. The same identity of composition may be traced between the meteorite of Chassigny and the peridot rock of New Zealand, known as dunite, through which grains of chromate of iron are scattered.

7. From the experiments of M. Daubrée in the manufacture of meteoric matter from the fusion of terrestrial rocks, it may be inferred that the meteorites were consolidated from a state of igneous fusion, in an atmosphere containing very little oxygen, which has been mainly used in the oxidisation of silicium, magnesium, sodium, and potassium; while the more refractory iron, which is represented in the superficial portions of our earth by the almost universally distributed oxide, occurs in the metallic state. This poverty in oxygen, as we shall see presently, is also characteristic of the deeper-seated basic layer of the crystalline rocks in the earth's crust.

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The difference which exists between some of the meteorites containing a small percentage of iron and the eruptive magnesian igneous rocks, of which Lherzolite may be taken as a type, may be accounted for by this poverty of oxygen. Both are composed of magnesian silicates, containing iron, nickel, phosphorus, sulphur, and the like; but these are arranged in a different manner in each. In the meteorite the nickel and the iron are metallic; in the rock they are in combination with oxygen and silica. In the one, the phosphorus is directly united to the metals forming phosphides; in the other it is in the condition of phosphoric acid and forms phosphates. And from this it may be inferred that in the meteorites oxygen is not present in sufficient force to act upon the metals, while in the superficial parts of our earth it is sufficient to oxidise nearly all the elements capable of oxidisation.

8. The meteorites, therefore, may be said to be united to the earth by the closest possible bond of chemical identity, and we may reasonably use their evidence as to the present constitution and the probable future of the earth.

9. We will now pass on to the investigation of extra-terrestrial matter in a state of combustion. The wonderful results of spectrum analysis have revealed to us, during the last few years, the constitution of the great centre of our system, the sustainer of life, the fount of energy, the glorious sun. By the labours of Kirchhoff, Angström, Huggins, Lockyer, Miller,* and others, it is proved to be a great fiery globe, very much as it was

* Roscoe, *Spectrum Analysis*; Lockyer, *Lessons in Astronomy*.

imagined to be by the cosmogonists, surrounded by an atmosphere of intensely heated particles, that are continually rising and falling according to their change of temperature. The willow-leaf-shaped bodies which constitute the photosphere or dazzling envelope, are probably fore-shortened views of these flaming clouds which conceal the true surface of the interior. Above this is extended the atmosphere of heated vapours or chromosphere, consisting mainly of hydrogen in its upper part, in which from time to time the most astounding disturbances are visible. One such fiery hurricane is thus described by Dr. Young: an enormous protuberance or hydrogen cloud, in no way remarkable, floated above the photosphere at a height of some 15,000 miles, but connected with it by vertical columns, being about 100,000 miles long by 54,000 miles high. In less than 25 minutes, or the interval between two observations, it "was blown to shreds by some inconceivable uprush from beneath," and the air, so to speak, was filled with flying *débris*, which "rose with a motion almost perceptible to the eye, until in 10 minutes the uppermost were more than 200,000 miles above the solar surface." The velocity of this ascent was 166 miles per second. As the filaments rose they gradually dissolved away like clouds. In the meantime a tiny bright spot or "thunder-head," observed before, "had grown into a mass of rolling and ever-changing flame, to speak according to appearances. First it was crowded down as it were along the solar surface; later it rose almost pyramidally 50,000 miles in height; then its summit was drawn out into long filaments and threads, which were most

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curiously rolled backwards and downwards like the volutes of an Ionic capital: and finally it faded away, and by 2.30 had vanished like the other."—(*Nature*, 1871.)

10. The following solar elements have been determined:—

Sodium.	Zinc.	Titanium.
Iron.	Calcium.	Strontium?
Magnesium.	Chromium.	Cadmium?
Barium.	Nickel.	Potassium?
Copper.	Hydrogen.	

Three other metals—lead, cerium, and uranium—are considered by Mr. Lockyer * also to exist probably in the sun. These elements, with the exception of the two last mentioned, occur also in the meteorites as well as in the earth, or, in other words, the matter whence the sunlight and heat are derived is mainly the same in kind as that which falls to the earth in the form of the cold and solid meteorite.

There is another fact to be noted which has an important bearing on our argument, that in the sun the elements are arranged according to their vapour-densities, the red flaring hydrogen far outreaching the atmosphere of the other gases, and apparently not obeying the law of gaseous diffusion, which is invariable on the earth.

11. The stars have also been proved by spectrum analysis to possess the same constitution as our sun, "each consisting of a white-hot nucleus, giving off a continuous spectrum, surrounded by an incandescent

* *Proceedings of Royal Society*, No. xxi. p. 512.

atmosphere, in which exist the absorbent vapours of the particular metals." In the star Aldebaran nine elements have been detected by Mr. Huggins and Dr. Miller :—

Hydrogen.	Calcium.	Mercury.
Sodium.	Iron.	Bismuth.
Magnesium.	Antimony.	Tellurium.

The three last of these have not been met with among the solar elements. Sodium, magnesium, calcium, iron, and bismuth are present in the atmosphere of α Orionis. In most of the other stars hydrogen is present, and to its incandescence was owing the sudden splendour of a small star in the constellation of the Northern Crown, which was observed by Mr. Huggins to flare out in 1866, and as suddenly to relapse into its normal insignificance. In this case we have, possibly, an example of a stellar catastrophe, which may have been brought about by the impact of one of the satellites to which the star in question is the central sun. Some of the stars are, however, without hydrogen (Lockyer), as α Orionis and β Pegasi.

12. Some of the nebulæ consist of gaseous matter, containing hydrogen and perhaps nitrogen, while others present a continuous spectrum, which proves that they are composed of solid matter. All are in a state of intense incandescence. Carbon, or some compound of it has, perhaps, been discovered by Mr. Huggins in some of the comets.

13. From all these facts we may conclude that matter in the universe is essentially the same in kind, but in different states of aggregation, being sometimes in a gaseous condition and incandescent, and at other

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times cold and collected together in solid masses as in the meteorites, and, it may be added, in the moon. And between these two extremes of temperature the planets form the intermediate links.

14. A comparison of the present condition of the earth with the only planet of which the true surface can be seen, renders it very probable that all the planets are in a somewhat similar state. The researches of Professor Phillips and others, in Mars, prove that its surface is occupied by sea and land, and is subject to the same climate laws as our own. As the winter comes on, the snows gradually extend towards the equator, until they cover an area round the poles, extending as far as the 45th degree of latitude, with a shining mantle of white. When the spring-time comes round they retreat again, until at midsummer they form an arctic barrier, reaching 10 degrees round the poles. Mars therefore has polar, temperate, and equatorial regions similar to that which we possess, and it presents the same phenomena as would be observed, were an astronomer on its surface to direct his telescope to our globe. We are therefore justified in concluding that, in all essential features, Mars is a mere repetition of the earth. So far as relates to heat and cold, summer and winter, land and water, and atmospheric conditions generally, there is every reason for belief that it is as well fitted for the maintenance of life as our own planet.

Its outer crust may also be inferred to be largely composed of marine strata, the product of the erosion of the land by water; and its interior is undoubtedly in a heated condition, since were it not for an internal store of energy similar to that which is possessed by

the earth, the cold on its surface would be too intense to allow of the observed changes of climate, so strictly analogous to our own.*

The singular identity of condition between Mars and the earth implies a close relationship between all the planets, even of those of which the true surfaces are concealed, like Jupiter, by an envelope of cloud. They too, have been proved by Father Secchi and M. Jansen, to possess atmospheres charged with aqueous vapour.

15. What is the place which the earth occupies in relation to its fellow-travellers round the sun? Have we any evidence that it was once heated at the surface like the sun, and is there reason for the belief that it will ultimately become as cold, dead, and lifeless, as the meteorites? In answering these questions I will first of all appeal to its present internal condition.

16. The existence of volcanoes † and hot springs on the surface of the earth testifies to the heated condition of certain areas below the surface, and the increase of temperature at the rate of one degree for every forty or seventy feet of descent, observed in mines, proves that this heated condition of the interior is not local, but that there is a steady flow of heat from the centre towards the circumference. According to Sir Charles Lyell the increase of one degree for every sixty-five

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* Huggins remarks that this distant planet takes to its own use less than four-tenths of the energy which it receives as heat.—Roscoe, *Spectrum Analysis*, Appendix, p. 270. A greater distance from the sun implies also that it receives less solar heat than the earth.

† Some of the views in this Essay have been advanced in the *Edinburgh Review*, January 1870: "Geological Theory in Britain."

feet of descent would be sufficient to boil water at a depth of two, and to melt iron at a depth of thirty-four, miles. Below this the heat would be sufficient to fuse all known substances. If then we ignore the effects of pressure on the fusing points of the different elements, a greater thickness than thirty or forty miles cannot be assigned to the solid crust of the earth, which must rest everywhere on matter kept fluid by intense heat. But we have no right to ignore the effect of pressure, since it has been proved experimentally that some substances can absorb a considerable amount of heat under pressure, without passing into a liquid or gaseous condition. The force of gravitation exerted by thirty or forty miles of solid rock must be enormous, and therefore, unless it can be proved that the melting power of the heat at that depth preponderates over the possible effect of pressure of the superincumbent rock, we cannot be sure of the existence of a molten zone, supporting everywhere the solid crust. If the pressure preponderate, as Mr. Scrope conjectures, the earth may be solid to the very core, and if the heated matter be kept solid by pressure at any point, if that pressure be relaxed it will become fluid. It therefore follows that the outpouring of lava from volcanoes has no necessary connexion with the thickness of the earth's crust. By this line of enquiry, then, we can only safely infer, that the deeper-seated portions of the earth are heated to an inconceivable degree, and as we do not know how substances, heated to such a degree as they must be under those conditions, would behave under such enormous

pressure, we cannot tell whether they would assume the solid, the molten, or even the gaseous state.

17. Nor can we obtain any light on this point from the consideration of the phenomena of precession and nutation, from which Mr. Hopkins * ingeniously argued, some thirty years ago, that the solid crust of the earth must be at least from 800 to 1000 miles thick. Sir William Thomson † has inferred from the same premises, that "no continuous liquid vesicle at all approaching to the dimensions of a spheroid 6000 miles in diameter can possibly exist in the earth's interior, without rendering the phenomena of precession and nutation sensibly different from what they are," and that the earth, as a whole, must be far more rigid than glass and probably even more rigid than steel; "while the interior must be on the whole more rigid, probably many times more rigid, than the upper crust." These conclusions, drawn by two men of such eminence, clash with no well-ascertained geological facts. If the earth be a solid mass, the phenomena of volcanoes and the presence of foci of seismic energy at different depths, may be explained by the unequal ‡ contraction of the cooling mass, by which the upper portions of the earth's crust would crush down upon the more highly heated matter below, thus turning mechanical work into heat localised in certain points, which need not necessarily be at an enormous distance from the surface. Mr.

* *Phil. Trans.* 1839, 40–42; *Brit. Assoc. Rep.* 1847.

† *On the Rigidity of the Earth*, *Phil. Trans.*, vol. cliii.

‡ "For equal decrements of heat, the hotter nucleus contracts more than the envelope of solid matter." – Mallet, Introd. to Palmieri's *Vesuvius*.

Mallet urges in support of this view that less than one-fourth of the annual amount of heat lost by the earth would produce more than sufficient contraction to cause these results.

This ingenious application of the theory of precession and nutation to the analysis of the thickness of the earth's crust might indeed be considered decisive, had not M. Delaunay * demonstrated, before the French Academy, by actual experiment, that it has no bearing on the problem. Both Mr. Hopkins and Sir William Thomson assumed in their calculations that the molten rock would be absolutely fluid and altogether devoid of viscidity. The eminent French mathematician proved that this latter property, inherent in all matter, would be sufficient to cause the earth, whether fluid or not in the interior, to behave precisely as if it were one homogeneous solid body. By imparting a slow revolving motion to a glass globe filled with water, he showed that both water and glass revolved precisely as if the whole had been frozen into one solid mass. We cannot, therefore, deduce by this method either the fluidity or solidity of the interior of the earth, but we must be content with a recognition of the fact that it is enormously heated at the present time, and that it is slowly losing its heat by conduction through the upper strata, as well as by convection by means of hot springs and volcanoes.

18. If, however, the earth be slowly losing heat

* *Comptes rendus*, 13 *juillet* 1868, *sur l'hypothèse de la fluidité intérieure du globe terrestre.*

sufficient, according to Mr. Mallet,* to liquefy 777 cubic miles of ice per annum into water at 32°, it will follow that formerly it must have been hotter than it is now, until it was even in a molten condition at the surface. And from this argument, Sir William Thomson † justly points out that since the energy in the earth was greater in remote geological periods, the forces reacted on its surface more powerfully than they do now,—in other words, that cheques drawn by the geologists on the "bank of force" are honoured equally with those drawn on the "bank of time." We may, therefore, conclude that the uniformitarian mode of measuring geological phenomena by an appeal to the present order of things is not altogether true, insomuch as it neglects to take into account the greater store of energy in the earth in remote periods. If there be any truth in physics, it must be allowed that the terrestrial is a "decaying energy," although "now as compared to man's experience, and even to all historic time, apparently uniform and always the same."

19. The time necessary for the cooling of the earth from a state of fusion at the surface to its present condition is computed by Sir W. Thomson as not more than 100 million years.‡ According, however, to Professor Haughton, 1018 millions of years passed

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* Mallet, *Vesuvius*, by Palmieri. Introduction.

† *Trans. Geol. Soc. of Glasgow*, No. iii. p. 25 and p. 215. Sir W. Thomson, in p. 231, calls attention to the fact that the hypothesis in Lyell's *Principles*, 1868, vol. ii. p. 242, that electricity, chemical action, or magnetism, "may restore to the planet the heat supposed to be lost by radiation," is directly opposed to the principle of dissipation of energy, which is held by all the leading physicists of the day.

‡ *Phil. Mag.* January 1863.

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away while the earth was cooling from 212° Fahr. to 122° Fahr., and 1280 millions more in cooling from 122° to 77°.*

20. The evidence offered by the internal heat that the earth was once molten at the surface is amply confirmed by an examination of the igneous rocks, which, from their chemical identity with the ejecta of volcanoes, are proved to have been produced by heat, just as the aqueous rocks are due to the mechanical action of water, or the organic (coal, limestone, &c.) to the work done by living organisms. From the fact that they penetrate the stratified rocks, we may gather that they are derived from matter in position below these latter, and we may also infer from the latter being formed of materials which may be traced back to the former,† that there was a time in the history of the earth when igneous rocks constituted the only land. The crystalline structure, and the glass and water cavities in their component crystals, prove that they were consolidated from a highly heated condition in presence of water and under very considerable pressure.‡ For their classification we are indebted to the eminent French chemist, M. Durocher,§ according to whom they are divided into two great divisions, that containing a

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* *Reader*, February 1864; see also Phillips' *Address to Geological Section of British Association*, 1864.

† See Haughton's *Manual of Geology*, pp. 50–51.

‡ Sorby has calculated that the granites of Cornwall and Aberdeen were consolidated under pressures varying from fifty to seventy-eight thousand feet of rock.

§ *Essai de Pétrologie comparée. Ann. des Mines*, 5 sér. tom. xi. Translated by Haughton. *Man. of Geology*, Lecture I. Appendix A.

large percentage of silica, or the siliceous, and that containing a large percentage of the earthy bases, or the basic, with certain intermediate forms. To the first of these belong the granites, eurites, as well as the trachytes, pitch-stones, pearlites, obsidians, and pumices. To the second, the diorites, basalts, dolerites, and leucitic and augitic lavas. And these two divisions contrast not merely in their relative density, but also in their chemical constitution, as may be seen in the opposite table, borrowed from Professor Haughton's translation of Durocher's *Essay*. The siliceous group is remarkable for its richness in silica and poverty in iron, lime, and magnesia; while the basic is equally remarkable for its poverty in silica and richness in iron, lime, and magnesia. The percentage of oxygen is also greater in the former than in the latter.

21. From these trenchant differences we may infer with Durocher and Professor Haughton that these two classes of rock are derived from two distinct layers or "magmas" beneath the stratified rocks, their relative position being marked by the time of their appearance on the surface of the earth. And since the siliceous class, as represented by the granites,* eurites, and

* The view held by many distinguished geologists that the igneous are merely the result of the melting of the stratified rocks seems to be negatived by facts brought forward by Mr. David Forbes, that the latter do not present the same uniformity of composition as the former, and do not always possess the same chemical constitution. In some cases, however, where the chemical elements in the stratified rock subjected to metamorphic action are identical with those which are met with in the igneous, they have re-assumed the crystalline igneous form. "My experience in the field, assisted by the microscope and laboratory," writes Mr. Forbes, "has satisfied me that very many of the so-called granites and gneisses are really sedimentary products

Limits of Proportions in Igneous Rocks.	Silica.	Alumina.	Potash.	Soda.	Lime.	Magnesia.	Oxides of Iron and Manganese.	Water. Fluorine. Carb. Acid.	Specific Gravity. Natural.	Specific Gravity. Vitrified artificially.	Oxygen.
1. Siliceous	62—78	11—20	3—6	1—6	0·5—2	0·5—2	0·5—4	0.5—3	2·4—2·7	2·35—2·46	
2. Basic	45—58	11—20	0·5—3	1—6	5–12	3–12	7–20	0.5—4	2·8—3·2	2·5—2·84	
Mean in two Magmas:											
1. Siliceous	71·0	16·0	4·5	2·5	1·0	1·0	2·5	1·2	2·65	2·40	48·22
2. Basic	51·5	16·0	1·0	3·0	8·0	6·0	13·0	1·3	2·95	2·72	43·60

petrosilex is met with in far greater abundance in the older rocks than the basic, while as represented by the obsidians and trachytes it is comparatively rare among modern volcanic products, it may be fairly taken to be the upper of the two and the first to solidify. This conclusion is further confirmed by the occurrence of the

products of the breaking up of true igneous eruptive rocks, stratified by aqueous agency, and subsequently, as it were, re-constructed or consolidated. At the same time, however, I have also come to the conclusion that there are true eruptive granites of igneous origin." Because *some* granites are metamorphic, it by no means follows that *all* are also metamorphic. Mr Forbes finally sums up the arguments against the igneous origin of granite, and several other plutonic rocks, as follows. It is argued,—

"1. That granite contains free quartz. As before stated, this is also the case in many volcanic lavas, and the remarks made on this subject, when considering the possibility of the presence of free silica in silicates, are all applicable here.

"2. The quartz in granite is of specific gravity 2·6, or the same as that of quartz of aqueous origin. As previously stated, this is also the case with the quartz from volcanic lavas.

"3. The quartz from granite contains water. This is also the case with the quartz out of the rocks of the volcanic island of Ponza in the Bay of Naples, and in the volcanic lavas from Peru.

"4. That in granites some of the more fusible minerals have often solidified and crystallised before the less fusible ones.

"In the lavas from Vesuvius it is common to find crystals of refractory leucite sitting upon the easily fusible augite which had crystallised first.

"5. That granite frequently contains hydrated minerals. The quartz, felspar, nepheline, and idocrase from Vesuvius all contain water. A specimen on the table, broken out of the lava current of March 1865, whilst still flowing from Etna, contains crystals of stilbite.

"It appears to me, therefore, that when the facts and arguments on both sides of this question have been impartially considered, the conclusion will be drawn that there are true eruptive igneous granites, and that the arguments advanced against the igneous origin of granite are inconsistent as well as inconclusive." Forbes, *Journal of Chemical Society*, June 1868. *Chemical Geology*, reprint, pp. 19-20.

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basic rocks in fissures in the granitic rocks, as for example, those of greenstone traversing the granite near Newry. The granitic plateau of Auvergne is penetrated by the volcanic vents which poured out at one epoch trachyte,* and at another basalt. In both these cases it is obvious that the siliceous rocks were the first to solidify, and that they have been subsequently traversed by the basic proceeding from beneath. On the other hand, there is no case on record of any basic rock being traversed by any one of the granitic or older divisions of the siliceous group. It may, therefore, be inferred that the siliceous magma is that upon which the stratified rocks are based, affording by its degradation the materials out of which the older of them are composed, while below is the basic magma.

22. This arrangement is rendered necessary by the difference in their specific gravities, by which the lighter siliceous would float over the denser basic strata, if both were molten, just as oil floats on water or slag on a mass of molten iron.

23. The constitution of the internal parts of the earth below both these layers may be inferred from its comparison with the meteorites. The density of the whole earth is 5·5, that of the siliceous layer 2·4, and of the basic 2·72, and it therefore follows that the zones below these must consist of bodies of a greater density than 5·5, that is to say, of the heavier bases and metals. Sir

* The trachyte in this volcanic region is probably derived from the melting of the granite, since large crystals of orthoclase are frequently entangled in its mass. These setals have evidently been melted out of a solid crystalline rock, such as porphyritic granite.

W. Thomson and Professor Haughton throw out the speculation that the central mass may consist of metallic iron like the unoxidised holosiderites, and the comparison instituted by MM. Meunier and Daubrée between meteoric and terrestrial matter lends great weight to the hypothesis. The former draws the following parallel :—

METEORITES.

		Density.	Terrestrial Rocks.
1.	Holosiderites	7·0 to 8·0	?
2.	Siderites + stony grains ..	7·1 „ 7·8	?
3.	Meteorites very rich in iron ..	6·5 „ 7·0	?
4.	„ containing small per cent. of iron..	3·1 „ 3·8	= Lherzolite.
5.	Meteorites containing peridot	3·5	= Peridot rocks.
6.	„ „ alumina	3·0 „ 3·2	= Basic lavas.
7.	„ „ carbon	1·9 „ 3·0	= granite and gneiss.

Although in this scheme the meteorites containing carbon can hardly be fairly taken to represent our stratified or siliceous rocks, it cannot be denied that numbers 4, 5, and 6 are very nearly identical with certain basic rocks. And since 1, 2, and 3 possess the density which is demanded by the interior of the earth, they may be viewed as examples of the central portion of the earth, which we cannot know by direct examination. This conclusion is further strengthened by the fact that the heavy metals are accidental, so to speak, in their occurrence both in the stratified and crystalline rocks, and can be traced home with certainty to neither, from which it follows that their source must be deep-seated and below both the siliceous and the basic rocks.

Their distribution in the surface rocks in the mineral lodes may be accounted for by the view that they have

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either been floated upwards through fissures by sublimation, for the most part in combination with chlorine, sulphur, and arsenic, or carried by the upward passage of intensely heated water. They would necessarily according to this view come within the range of the carbonic acid gas and the oxygen in the water, and be distributed in the superficial rocks as carbonates, sulphates, and oxides.*

We may therefore conceive of the earth as consisting of a central unoxidised metallic nucleus, around which are arranged the basic rocks, the siliceous, and finally the stratified, each zone being placed according to the relative density of its component parts in a state of intense heat.

24. Thus we have internal evidence not merely derived from the earth's present heat, but from the arrangement of its parts resulting from that heat, that there was a time in the earth's history when those rocks which now compose the solid crystalline parts of the earth's crust were molten. And we are further justified in concluding, with Durocher, Forbes, and other eminent chemical geologists, that the siliceous group of rocks was that which formed the first pellicle on the surface of the cooling globe. But all trace of this first pellicle has wholly disappeared by the marine and sub-aërial action, to be worked up over and over again in the stratified rocks, leaving merely the deeper-

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* The circulation of water in the earth is analogous to that in a kettle on a fire: the warmer currents are continually ascending, laden with various minerals, until in some cases they appear on the surface as hot springs. To supply their place the surface-water, bearing carbonic acid, is continually descending.

seated portion to be represented by the older granites, which, from their largely crystalline structure, have cooled for the most part with extreme slowness.

25. From all these facts, and throwing aside all cosmogonies, it follows that we may picture to ourselves the earth as once an incandescent body like the sun, intensely heated at the surface and surrounded by a fiery atmosphere, without life itself, but distributing the life-giving light and heat to its satellites.

On the one hand, the geologist and physicist point to a molten globe, which, from its very heat, must have been clothed with the gases of the metals and other elements not now found in our atmosphere; on the other, astronomy and chemistry show us a globe composed, so far as we know it, of terrestrial elements, incandescent, and a centre of light and heat. To put the two ideas together seems to be no forced union; they form a concept that transgresses no known physical law, and that agrees with every chemical, astronomical, and geological fact that has a bearing on the question.

The present condition, therefore, of the sun represents accurately a stage in the ancient history of the earth.

26. As the sun stage of its existence drew to a close, but while it yet remained molten at the surface, its atmosphere, according to Mr. Forbes, was probably composed, 1, of a zone of steam and dense vapours of compounds volatile at high temperatures, in which chloride of sodium would play an important part; 2, of a zone of carbonic acid gas; 3, of oxygen and nitrogen; and as the temperature continued to decrease, so as to

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allow of the condensation of the vapours, chloride of sodium would condense in such quantities as to form a layer of common salt ten feet thick over the whole globe. The steam would also condense and water collect in the inequalities of the cooling surface, and thus form oceans, which would be salt from the very beginning. Then began the great contest on the surface of the earth between fire and water, which has continued without interruption ever since—fire or plutonic energy ever tending to elevate or depress the land out of the reach of the waves; water—as rain, rivers, frost, snow, and sea—ever striving to reduce it to one uniform dead level near low-water mark. Out of this contest have sprung all the diversity of earth-sculpture and the varying relations of sea and land.

Such changes as these were inevitable on the earth while it was passing from the sun stage to what may be termed its planetary stage—in which the phenomena of life are the most important characters—of life, bounded, as Mr. Lockyer writes, by two extremes of temperature, "that at which steam condenses into water, and that at which vapour of water is frozen."

27. The sun stage of the earth's history is the first of these termini, and the second is shadowed forth in the future by the condition of the meteorites. If the present rate of the loss of heat by radiation be continued long enough, it is almost a truism to state that the earth will ultimately become cold to its very core, and life will cease to be found upon it, because of the low temperature.

We may, therefore, fairly hold that the sun and the

meteorites represent conditions through which the earth has passed or will ultimately have to pass.

28. As, however, the earth had a fiery beginning, so it is inevitable that it will have a fiery end, since all planetary matter is tending towards the great centre of the world-maelstrom, the sun, in a series of spirals.

"As surely," eloquently write Sir William Thomson and Professor Tait, "as the weights of a clock run down to their lowest position, from which they can never rise again unless fresh energy is communicated to them from some source not yet exhausted, so surely must planet after planet creep in, age by age, towards the sun; not one can escape its fiery end. In like manner the satellites of the planets must inevitably fall into their respective planets. When each comes within a few hundred thousand miles of his surface, if he is still incandescent, it must be melted and driven into vapour by radiant heat. Nor if he be crusted over and become dark and cool externally, can the doomed planet escape its fiery end. If it does not become incandescent, like a shooting star, by friction in its passage through his atmosphere, its first graze on his surface must produce a stupendous flash of light and heat: it may be at once, or it may be after two or three bounds, like a cannon-shot ricochetting on a surface of earth or water, the whole mass must be crushed, melted, and evaporated by a crash, generating in a moment some thousands of times as much heat as a coal of the same size would produce by burning." *

29. The heat and light of the sun are supposed by

* *Good Words*, October 10, 1862, p. 106.

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Sir William Thomson to have originated in the arrested motion of cosmical bodies which have fallen into it, and are considered by Dr. Mayer, and other eminent physicists, to be maintained by the constant gravitation into it of asteroids, meteorites, and planets.

"If the planet Mercury," writes Professor Tyndall, "were to strike the sun, the quantity of heat generated would cover the solar emission for nearly seven years; while the shock of Jupiter would cover the loss of 32,240 years; our earth would furnish a supply for 95 years."

30. As it has been proved by its present state that our earth had a fiery beginning, so it is shown by an appeal to the law of gravitation that it will have a fiery end. Nor are we justified in viewing this as a never-ending cycle of change, or as a kind of phœnix-life. For if we believe that the sun—the immediate goal of our planetary system—derives its light and heat from the impact of cosmical bodies, there must come a time when it will absorb all these into its own mass, unless we suppose with Kant that fresh matter be eternally drawn within the influence of its attraction—or, in other words, that the "Kosmos" of our own system is continually being "enlarged at the expense of Chaos,"—a supposition that is full of poetry, but not based on any known facts. When this comes to pass, it must inevitably gradually lose its light and gradually pass into the earth stage of developement. In all this a progress is clearly shown. The earth passed from the incandescent into the habitable state, and will have its individuality annihilated by falling into the sun, and the same fate will ultimately overtake the sun, if it be true

that it also is revolving round some enormously distant centre of attraction.

31. If, however, we may view the sun as picturing to our eyes the sun stage in the genesis of the earth, we may consider that the present state of the earth is in some degree prophetic of the time when the solar light will be quenched and its superficial heat so reduced as to admit of those chemical combinations now common on the earth prophetic of a time when the molten surface will become solid, the fiery clouds be replaced by aqueous vapour, and rain, river, and sea gradually cover up the igneous crystalline surface with sedimentary rocks, and the earth stage of development be initiated. This argument from sun to earth, and earth to sun, is founded on premises which are admitted on all sides to be true, while they are scattered through the pages of various writers; they can scarcely be termed false, when they are placed side by side and used as premises.

32. In fine, the inevitable conclusion derived from the study of the heavenly bodies of sun, earth, stars, meteorites, and nebulæ, is that the unmeasurable space is full of matter of the same kind, but aggregated in different fashions, sometimes being gaseous, at other times solid, sometimes in a state of the most intense heat, at other times cooled sufficiently to admit of the presence of life, as in the earth and Mars; or, lastly, cold, barren, and lifeless, as in the meteorites. A continual loss of energy is proceeding, and the tendency of our solar system, if not of the universe, is towards the cold state.

33. Such as these are the results of an inquiry in

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widely diverse fields in physics, astronomy, and geology. They prove that the earth is united by the closest bonds to the heavenly bodies, and that terrestrial change is one in a definite direction, in a straight line, so to speak, and not in a circle. The recognition of this change constitutes the doctrine of evolution. In the presence of the overwhelming evidence offered by physics and astronomy, it is scarcely possible to maintain that the present terrestrial energy is a measure of that which the earth possessed in remote geological periods, or to hold that the observed rate of change in the organic or inorganic world affords a means of estimating the changes at a time when the energy was greater than it is now. We must hold with Phillips, Murchison, and Sedgwick, that the forces in play on the surface in ancient times were stronger than they are now, and with Professor Huxley that the earth can no more return to her ancient conditions than a man can return to his childhood. The history of the earth is strictly analogous to that of a man: birth from a nebulous or chaotic state; a fiery, sunlike infancy and youth; middle age, in which all the vital phenomena are fully manifested; and old age, with decaying energy, and ultimately death. In the childhood of the earth the vital forces, on account of the greater heat, would certainly be more active than they are now in its old age, and new forms of life would be thrown off with greater swiftness, which, keeping in harmony with their changing environment, have probably given rise to the endless variety of Organic Nature.

W. BOYD DAWKINS.

VI.

The Use of Steam.

ould be difficult to overrate the influence of the f printing upon the great material and intellectual nce which the world has made during the last years. This great revolution, unapproached for ity in the preceding history of the world, has ıps been equalled, or, to speak more correctly, leled by the revolution of our own time caused by Jse of Steam. Although the steam-engine is, as ere, a child or a grandchild of the printing-press, ffect on the world has been very similar. It has lutionised customs and institutions and displaced l and political landmarks. And although we may been rendered somewhat indifferent by daily liarity and confused by the almost infinite number urposes to which steam is applied, we must all of erceive how completely we have committed our-es into the hands of steam, and made it necessary ur existence. It is not only that we have made of it to do things for us which we could not other- have done, but we have called it in to take a l in almost everything that we do; and in another ration at all events we shall have lost the art by h we used to do things for ourselves.

So multifarious, indeed, are the offices which steam now performs, that it is very difficult to form a general conception of the part it actually plays amongst us. If, however, we clear away the cloud of details in which the subject is involved, we may reduce its offices to two. It relieves man from the drudgery of life—the curse of sin—and it increases his physical powers, principally in locomotion, and hence his power of enjoyment.

We may form some estimate of the actual result produced in these directions.

From the best information at hand,* I conclude that in Great Britain at the present time steam is doing as much work as 12 millions of men could do—a total not far removed from that which would result from the labour of the entire population, not working as they do work, but working hard. Thus steam is doubling our working power, or doing as much work for us as we could do for ourselves.

What good, it may be asked, comes of all this? We work as hard or harder than our fathers ever worked. It is true that good obviously results in many ways. We live "better" than our predecessors did of old, and have more indulgences, notwithstanding that we are thicker on the ground. Our travelling consumes much work, and we are still improving our country, besides obtaining property abroad. But after all, such things do not absorb the work of the entire population; and we must remember that there are about 2 millions of horses in the country, whose work is

* *Report of the Coal Commission*, 1869.

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likewise equivalent to that of its human population. To account for all this, we must take into consideration the fact that although the English work as hard as ever they did, they do not work in the same way.

In the struggle between man and his destiny, it has been his effort rather to change the character of his yoke than to get rid of it altogether. Although they are included under the same name, a broad distinction must be drawn between the two kinds of human work—not between that of the head and the hands, although this often serves as a rough expression of the difference; but between that work which requires physical energy, the *digging*, in fact, and that which only requires attention, skill, and thought. Of these two kinds of work, it is the former which man has ever looked upon as his heaviest burden; and from which he has continually endeavoured to free himself, firstly, by shifting his share of it to the backs of others, even if he takes their share of the lighter kind; and, secondly, but with more credit to himself, by calling in the aid of contrivance to enable him to employ animal and material agents to do his share of the hard work, and leave him only the task of contriving and directing their movements.

This task, however, increases in proportion to the extent of the relief obtained. The work done by these agents is by no means all gain, as we may see in the case of the horse, the use of which necessitates the cultivation of more land, in order that there may be food for both men and horses.

Thus it is that although there is ample work for all, the bulk of it goes in tending horses and machines, and

very little human labour is directly employed in the pro duction of the necessaries of human life. This is per haps most evident to the farmer. The breaking of the soil has for ages been done by animals, the plough being so simple an instrument that it was invented early. This constitutes the heaviest agricultural work; but there was still much left to be done—thrashing, reaping, sowing, collecting, and hoeing, all of which were until the last fifty years done by human labour. Now, however, there is hardly one of the operations in farming which man need do for himself. All the heaviest work—the mowing, reaping, collecting, and even the lifting of the corn on to the stacks—is now done either by steam or horses, with the aid of mechanical contrivances, and the result is that there are often more horses than men actually employed on the land. And as it is with horses in agriculture, so it is with steam in almost all other fields of work.

It would, perhaps, be fairer to compare the work done by steam with the population of the world, the vast majority of which, to a certain extent, reaps the advantage of it. The entire work done by steam will not be found equal to more than the work of 25 millions of men, whereas the working population of the world is at least 250 millions.

These figures, although rough, give us an idea of the actual assistance which man derives from steam, and if we add to this the power which it gives him in travelling, we shall have estimated the whole material advantage which is directly derived from its use.

Of course I do not mean to assert that this is all that steam has done for us. In the case both of steam

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and of printing the result has extended far beyond the immediate reach of the agent. And just as printing has called into play a vast amount of thought and literary talent which formerly lay dormant—as it has, so to speak, blown a spark into a flame—so the introduction of the steam-engine has evolved from latent sources a vast amount of labour and ingenuity which could not otherwise have found employment. But although the results of the use of steam are not confined to those which spring directly from the use of the steam-engine, they are proportional to them, and any extension in the absolute help has been and will be immediately followed by an increase in the collateral effect.

This brings me to the consideration of the probable future of steam and of the possible improvement of the steam-engine.

In itself and in its immediate action, the agent in the present, as in the preceding, revolution is of the most matter-of-fact and graceless kind. Although the wheels and chimneys of the steam-engine are hardly more interesting than the black frame and letters of the printing-press, and the effect of the steam-engine in replacing picturesque horses is fairly parallel to the substitution of the black hard lines of printing for the graceful manuscript, yet the steam-engine has an intrinsic importance altogether wanting in the printing-press. This latter merely acts the part of the ball in the game, and it matters little whether as a press it is good, bad, or indifferent. But the qualities of the steam-engine are of the utmost importance to the part it plays. In printing, the principle is everything; whereas in the use of steam, whatever there is in the

principle can only be realised by the merits of the mechanical agent. The broad results of printing have been affected but little by the perfecting or improving of the art; and we should practically do very well if we had nothing but the first presses to work with now.

In the case of the use of steam, however, it was not until years after the principle had been recognised that the methods of applying it were sufficiently advanced for it to be of any practical value, and ever since up to the present time each fresh improvement in the economy of the steam-engine has been immediately followed by a further extension of its uses. Our interest in steam is therefore mainly centred upon the steam-engine and its possible capabilities. If the method of using steam were perfect—if it were applied to every possible purpose to which we could hope to apply it, then the only question of interest would be what possible changes in our condition might result from its further use. But so long as there is a possibility of any important extension of its power, it is to this that we must direct our enquiry. I have already explained how, speaking generally, the steam-engine may be said to have two duties to perform, and as regards the first of these, viz. the help it gives to man, the question is clearly one of economy, —will the work done compensate for the work spent in making the engine and procuring coal? With regard, on the other hand, to the second of these duties, viz. the increase which the engine adds to man's powers, the question is not only one of economy, as to whether the sport will pay for the candle, but it is also one of physical possibility. To travel at sixty

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miles an hour over land, or thirty over water, is not merely a question of trouble, for to do it we must make engines not only more powerful, but more powerful for their size.

It is not, however, only as a means of extending the usefulness of steam that the economy of the engines is of importance. It has a serious, almost a tragic, interest besides, in connexion with the limit of our coal.

In what opinion a coal-starved posterity will hold the dwellers in England at the present time is a doubtful, and at the same time a painful, question. They will doubtless honour us for the advance we have made in science, and for such monuments of our prosperity as we may leave to them; but they will be tempted to wish that we had spared the coal, at all events until we had perfected our methods of using it.

Should any one study the records of our time—as for instance, the Report of the last Coal Commission—there are two things which he will find it hard to believe, and which from his point of view will render it difficult for him to honour his ancestors. In the first place he will find that, with our eyes open, we were burning twice as much coal in our steam-engines as was necessary. Of the 30 million tons of British coal which are now annually consumed in steam-engines, at least 15 are wasted; that is to say, if proper care were taken with the engines, and these were made as good as we know how to make them, we should do what we now do with 15 million tons a year less than we now use. And he will also see that although we have scientific reasons—reasons which amount to a certainty—for believing that our best engines at the present time might

be greatly improved, yet we are making no systematic efforts to realise this result.

It is really hard to believe these things as thus stated, but they are nevertheless true. To a large extent they are due to the money value by which coal is measured. The saving in coal by a new engine would be largely balanced by the trouble and expense of the new engine, and no account is taken of the fact that while coal is exhaustible, and every pound we burn is so much the less for our children, expense in labour is only a tax on our own industry. By the present method nothing but a very considerable rise in the price of coal can limit its use to what we may call strictly legitimate purposes, unless the cost of labour from coal becomes equal to that of human labour. Up to the present time the price has been regulated rather by the supply than by the demand. The price of coal has been what it cost to get it—in many cases only sixpence or a shilling per ton being charged by the owners of the coal. But, on the other hand, we may say that to the community the value of the coal is the difference between the cost of getting it and the cost of human or animal labour, supposing care to be taken to use the coal in the most economical manner. The true mechanical importance of coal lies in the fact, that by means of it we can do much which we could not do without it, and such is the profusion with which we are supplied that, by restricting it to its legitimate purpose, it would last a long time. But by burning it for every possible purpose that adds either to our ease or indulgence we shall come to an end of it, and our posterity will have to fall back on their own power, to begin

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again and to learn the arts which we have lost. For people to acquire wealth in houses, furniture, roads, and whatever we may call the permanent part of the necessaries of life, has ever been held to redound to their credit; but this was when such things represented a contribution of the present to the welfare of a future generation, and it is a very different thing now that they are to be obtained simply by the burning of more coal. However much posterity may value our old houses and our old railroads, it is to be feared that they will lament the coal that has been wasted in producing them with our imperfect engines.

But whatever probability there may be that the consumption of coal will be reduced by its price, or whatever may be our views as to the duty of the community with regard to its national inheritance, we can have but one opinion as to our obligation to exert ourselves in rendering the means of using it perfect.

That the steam-engine is capable of further improvement there is now no doubt. We sometimes say that Watt gave us a perfect steam-engine, but in this we rather wish to express the debt we owe to him than to indicate the present state of the steam-engine. Although it may be said with truth that the average quantity of coal consumed in an engine is even now as great as it was in his time, yet this is due to the fact that many engines now work under much more untoward circumstances than they did then, as, for instance, locomotives and portable engines and engines working where there is no water to condense with. And besides this, there is now a greater proportion of old, worn-out, and bad engines. Watt's engines were all up to a certain

standard; whereas if we have some better engines now, we have others which are much worse. There is no doubt, however, that our best engines now are better than those which Watt made. We can now do with 2½ or 3 pounds of coal what he did with 4 or 5—a reduction which will bear comparison with that effected by Watt on the best engines of Smeaton before his time.

These improvements, which have been already effected, point the way to still further improvements. It has been by working with steam at greater pressures and expanding it further that the good has been effected. And of the witnesses examined before the Commission of 1869 (who were the engineers of the greatest experience in the country) there was not one who did not admit the possibility of working with still higher pressures, and thereby reducing the consumption of coal.

But the improvement which is possible is not a matter of opinion. The light which has been thrown upon the action of steam by the mechanical theory of heat and by the scientific discoveries of the last thirty years shows not only that there is advantage to be obtained, but also the possible extent of this advantage, and what we must do to obtain it. Hence it appears that by using steam at a pressure of two or three hundred pounds where we now use fifty or a hundred, and at pressures of one hundred where we now use twenty, we may make a pound of coal do as much as two do now.

But it is not sufficient that we should be able thus to predict with certainty the result of every new method of using steam. These theoretical results have to be

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realised in practice before they can be acted upon, and it is the accomplishment of this which takes so much time. Many of these conclusions have now been arrived at for twenty or thirty years, and yet the actual advance that has been made during that time falls far short of what it might have been. And since the difficulty increases as perfection is approached, it will, at the present rate, be many years before our anticipations are fully realised.

I have so far shown how important it is that what has to be done should be done quickly; how for each year of delay we burn some 15 million tons of coals, besides wasting the labour of raising them; and it now remains for me to examine what chance we may have of expediting the natural course of things.

The case is now very different from what it formerly was. We can now see what we are about, and there is no more groping in the dark. There are now certain definite alterations before us which we have every reason to believe will effect a great saving, and the question is, shall we leave them to a chance trial, or shall we take the bull by the horns and force them at once to a fair experimental test?

It is true that hitherto everything has been left to empirical advance, and that no systematic efforts have been made either by the nation or by those most directly interested in the use of steam. But are not the circumstances altered, and have we any excuse for thus leaving to accident what so vitally affects the well-being, not only of ourselves, but of our posterity?

There is a general impression that the steam-engine is the child of practical men, and that it has not been

scientifically developed, but has been the result of empirical and casual advance. A brief study, however, of its history in connexion with the contemporaneous history of science will serve to show the incorrectness of such a view. It will show that the steam-engine after all owes little to mere casual advance, but that its improvement has really been effected by systematic research—that of all the countless brains which have been employed upon it, it has only been from a few that it has received any real good. Such a review will also show how each mechanical step in the steam-engine has been preceded by, and has thus been the result of, the discovery of some physical law or property of steam.

It is not easy for one who knows anything well to go back and in imagination place himself in the position of those who did not know it. The properties of steam are now well known to us, but this is the result of our fathers' work,—the properties in question are not of themselves obvious. Although we should now feel it an insult to be told that if a closed vessel containing water were left on the fire the steam would burst it; or, again, that if a closed vessel is filled with steam and cooled the steam will condense and leave a vacuum: yet we may ask ourselves the question, how do we know this—have we ever seen it done, or has someone told us? We must admit that we have learnt these things, and not discovered them; there are few people who have ever seen a vessel burst, and still fewer who have seen one emptied by steam; so that if no one had told us we should have been ignorant of those facts. Now this is precisely the

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condition in which people were 200 years ago. There were no boilers in those days which could burst, and by their explosions inform the whole world of the nature of steam. All that was known then was what was learnt in the kitchen ; even the tea-kettle did not then exist.

Although doubtless the impulse which science received in the seventeenth century was due in a great measure to the publication of the works of Hero and Archimedes, yet the very early history of the steam-engine affords us but little instruction. Every spouted kettle or pot must have shown that steam afforded the means of raising water or of producing an artificial wind; and there was but little credit in observing just so much and no more of the power of steam as was forced upon the attention by the ordinary phenomena of everyday life. Accordingly, although there were previous attempts to give motion by steam, the real history of the steam-engine commences with its useful history. It was not until the middle of the seventeenth century that steam was seriously thought of as a possible source of power.

There were many things which at that time conspired to set thinkers on the *qui vive* to find a means of driving machinery. Natural philosophy had been advancing for a few years previously by strides greater than it had taken during many centuries before. Just at this time the Royal Society had been founded, and had collected in London some of the ablest philosophers of all nations, and, by the facilities it afforded for the communication and publication of ideas, had given a great impulse to scientific research. And at this time engineering and mining enterprise had been carried to

the limits which the natural sources of power would allow, and the working of the most valuable mines in England could not be pursued for want of more powerful hydraulic machinery to replace the wind, water, and horse mills which were at that time the only means of raising water.

The first serious attempt or even idea of making real use of steam was that of the Marquess of Worcester in 1655. We know but little of his idea, and still less about his actual experiments. His engine, however, seems to have been a magnified example of the kettle boiling over, and to have been a direct result of the translation of Hero's works. The Marquess was, however, the first to show what steam could do, and to realise its possible importance.

In 1675, twenty years after the Marquess of Worcester published the account of his engine, Robert Hooke wrote the following cypher at the end of his description of Helioscopes:—*a a, a æ, b, c c, d d, e e e e e e, g, i i i, l, m m m, n n, o o, p p, q, r r r r, s, t t t, u u u u u*, with an accompanying note:—"*A new invention in* Mechanics *of prodigeous use, exceeding the chimeras of perpetual motions, for several uses.*" This, being deciphered, reads, "premit aer vacuum quod ab igne relictum est."

This note contains the earliest hint of the possibility of using the atmospheric pressure for power. It is so crude, however, that had it been written by an ordinary man it might have been passed without notice. But it comes from Robert Hooke, the most brilliant mechanical genius that ever lived, who discovered for us the function which air performs in sustaining fire and life—who invented the watch as well as the last

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or principle on which it acts, and to whom we owe numberless mechanical contrivances now known as Hooke's joint, Hooke's gear, &c. And besides, this note is associated in a marked manner with some of his most important discoveries. It forms one of ten inventions, in the second of which he gives the inverted catenary as the true form for the arch, and in the third, the law of elasticity, "ut extensio sic vis," which is now known as Hooke's law. With such surroundings the passage, short as it is, is worthy of notice. It shows clearly that at this early date the principle of the steam-engine was recognised by Hooke, although he probably did not see his way to the requisite contrivance.

At this time Papin, then in England, was engaged in assisting Hooke and Boyle in experiments with the air-pump, and in 1681 he invented Papin's digester, an instrument designed to withstand the pressure of steam and, as its name implies, used for dissolving bones and other things in hot water. While conducting these experiments, Papin became very familiar with the elastic force of steam, and when, just at this time, Hooke discovered that in an open vessel water could not be heated above 212°, Papin found that other effects could be produced in his closed vessel. He had also, in conjunction with Huggins, shown that in a vacuum water would boil even when it did not feel warm to the hand. He also measured the quantity of gas to be obtained by exploding gunpowder in small quantities in the receiver of an air-pump.*

* See *Phil. Trans.* 1683 to 1687.

These facts are important as it was this experience which ultimately led Papin to the invention of the steam-engine so far as he invented it.

In [illegible] he was trying to transmit power from one place to another, and having been accustomed to the air-pump, he conceived the idea of effecting his object by sucking air through a pipe, and it was in his efforts to do this that he hit upon the idea of the cylinder and piston, which has been a feature of the steam-engine ever since. He placed the pumps at one end of his pipe, and at the other a cylinder and piston for the atmosphere to act on. And as the only object of his pumps and suction pipe was to create a vacuum under the piston, it was a simple step to arrive at the conclusion that if he could make the vacuum by any other means, he might dispense with the pumps and pipe.

When Papin first proposed his scheme, Hooke pointed out to him, before the Royal Society, that the elasticity of the air would defeat his object, and in some correspondence which Hooke had with Newcomen (who was [illegible] contemplating the erection of one of Papin's [illegible] from which Hooke was dissuading him), he [illegible] he make a speedy vacuum under your [illegible] your work is done." Whether Hooke [illegible] this to Papin or not we do not know, but [illegible] he suggested it to Newcomen is [illegible] of the Royal Society, and it seems [illegible] the two men were then in daily inter[illegible] each of them knew the other's mind [illegible] more probable, as in 1687 Papin tried [illegible] vacuum in his cylinder by rarefying the [illegible] thus realising the idea which Hooke

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had conceived ten years previously. This method did not answer, and was abandoned; soon afterwards, however, Papin's former experience came to his aid, and he substituted water for gunpowder. He put water into his cylinder, and a fire under it, and when the steam had filled the cylinder, he removed the fire, upon which the steam condensed, and left a vacuum under the piston. He tried this successfully with a small model, and published an account of it in 1690. He did not, however, give it a practical trial, and we can now see that it would have failed to be of any practical good in the state of mechanical construction at that time; he himself foresaw the difficulty of getting his cylinder constructed.

It was now that Savery introduced his engine—an improvement on that of the Marquess of Worcester—in which he employed the condensing property of the steam as well as its expansive force. He did not follow Papin in the use of the piston, and was probably not aware of his invention; but his engine was a step in advance of Papin's, and possessed a feature which was adopted in subsequent engines. This was the separation of the boiler from the vessel in which the work was performed and the steam was condensed. His engine has also an historical importance as being the first that was used on a large scale.

This engine was used in some of the mines in Cornwall, but it had one great drawback. It would raise water very well to a height of fifty or sixty feet, but as the water was forced up directly by the pressure of steam, it was difficult to get bodies strong enough to raise it to greater heights. It is sometimes asserted that

the Marquess of Worcester suffered at the hands of an ignorant generation, inasmuch as his invention was not appreciated, but it seems that even when perfected and improved, as it was by Savery, it was of no practical value, the difficulty of making boilers being alone sufficient to prevent its adoption, a difficulty which would have prevented its use even at the present time.

In 1705 Newcomen took out his patent for the atmospheric engine, in which he used Papin's cylinder and piston, but, like Savery, used a separate boiler.

Newcomen, who was an ironmonger, and lived at Dartmouth, had probably seen Savery's engine, and was aware of its deficiencies. He had also, as has been previously stated, the benefit of the advice of Hooke.

How much Hooke had to do with the invention of the first steam-engine we shall never know. It is, however, simple justice to notice that he was the first to record a conception of it; and that those who are known as its inventors had been discussing the subject with him for years before they brought anything to perfection. It may be that Hooke never pursued the subject with earnestness. It came to him late in life, when he was much occupied and his health was bad. He died in 1703, five years after Savery had patented his engine and two years before Newcomen took out his patent.

Very soon after their invention Newcomen's engines were largely used in the mining districts, and although we are apt to look back on them with something of contempt, there is no doubt that they played a very important part in the prosperity of the country.

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They were of large size, having cylinders from 50 to 70 inches in diameter, and sometimes actually doing as much work as fifty horses; and it was solely by their aid that mining was carried on. They were, however, very bulky and costly, the charge for one of them seems to have varied according to the size, from 900*l.* to 1600*l.*, no inconsiderable sums in those days. This doubtless limited their use, but by far the greatest drawback was the quantity of coal they burnt. They required from 3 to 4 cwt. of coal per day to do as much work as a horse.

With the exception of the introduction of self-acting machinery to shut the steam on and off, these engines remained without improvement for nearly fifty years; and it is important to notice that, although they were acknowledged to be imperfect, and many contrivances—some of them very expensive ones—were tried to improve them, yet no systematic attempts seem to have been made to determine the best proportions for their various parts. Several suggestive facts were known, such as the advantage of large engines over small ones, and that it was more economical to work with an imperfect vacuum—but they led to no further improvements. It was not that the engine was waiting for further discoveries, it was simply a case of getting the best result from the fire engine as it was then. This is shown by the great advance to perfection which Smeaton was able to effect.

In 1750 this great engineer, having to use steam engines, had his attention called to their imperfections and to the imperfect state of the knowledge concerning them. He then took them in hand in the masterly

manner characteristic of everything he did. He did not try fresh "dodges"; but being somewhat disappointed in the performance of one of these engines which he had erected, he first of all set to work to get information about the performance of the engines then in existence; and his report furnishes us with a good idea of the state of the steam-engine in his time, fifty years after its invention.

He found that in the Newcastle district there had been in all about 100 engines built; but that of these only 57 at that time continued in work. Taking 15 of these engines as samples, he found that the average work they did was about that of 25 horses, and that they burnt about 50 lbs. of coal per horse power per hour. In Cornwall, where coal was less plentiful, he found that the engines were of a rather better type, and that there were about 18 large engines, which averaged 28-horse power.*

Having collected this information, Smeaton constructed at his own expense an experimental engine, which was large enough to give the results a practical character, and at the same time was well within the control of one man. It was made especially with the view of trying the effects of various adjustments; and his method of experimenting was to ascertain the coal required to pump a certain quantity of water, then to vary one part of the engine and ascertain the effect upon the consumption.†

By the construction of this engine, Smeaton completely altered the state of knowledge respecting the fire-engine.

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* Farey, *On the Steam Engine*, p. 234. † *Ib.* p. 166.

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He determined the best proportions for every part, and by simply paying attention to these points he made engines to do their work with half the quantity of coal they had previously burnt. Hitherto, the only guide which engine-makers had to go by had been vague impressions and guesses, in the place of which he gave them definite rules. He also improved the methods of constructing engines. The boring of the cylinders was the greatest difficulty. It had formerly been thought sufficient if they were not more than a quarter of an inch out of the round, but he so improved the method as to ensure their being round.

The fire-engine, as finished by Smeaton, was by no means a despicable performance. One example, which he himself erected, worked up to 100-horse power, and only burnt about 16 lbs. of coal in doing as much as that for which the previous engines had required 60 lbs.* It seems that these engines were favourites for certain purposes long after Watt had effected his improvements, and not only did the old ones continue in use, but fresh ones were put down for many years. Smeaton, however, added nothing new in principle to the steam-engine. The only properties that he recognised in steam were those described by Papin, "that when steam it would spring like air, and afterwards would condense itself so well by cold that it had no appearance of force or spring."

I have dwelt at considerable length on this part of my subject for the sake of showing that the first step in the invention of the steam-engine, although, on

* Smeaton's *Reports*, vol. ii. p. 77.

the one side, a direct answer to the appeal from the mines for more power, was nevertheless the result of the experimental researches and the discoveries of the properties of steam by Hooke, Boyle, and Papin, in the early days of the Royal Society; and also for the sake of definitely proving how little was done in the way of perfecting the fire-engine, by the method of promiscuous trial and happy guess-work, although this was carried on for a period of fifty years, and how certainly and quickly improvement rewarded the systematic efforts of Smeaton.

These mechanical improvements of Smeaton conclude the first period in the history of the steam-engine; they were immediately followed by further discoveries in the properties of steam, which were to initiate the second step of advance, and to which they themselves had in no small degree contributed.

Smeaton in his work on the steam-engine only preceded Watt by a few years; and if we look at the subject from a mechanical point of view, it seems strange that he did not forestall him in his discoveries. As regards talent, it would be hard to judge between the two men. They seem to have had much the same cast of mind, and certain it is that as an engineer Smeaton has never been surpassed. He is usually called the father of engineers, and his reports are studied at the present time, not as matters of history, but for what may be learnt from them. Both he and Watt were brought up to the same calling as mathematical instrument-makers. And the great experience which Smeaton must have gained in the great works which he constructed, commencing with Eddystone Lighthouse,

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and in his investigation into the power of wind and water, would, one would have thought, have placed him at an advantage. He was of the two the more intimately acquainted with the engine and its failings, and in his reports he discusses the very anomalies which eventually led Watt to his discoveries, and yet he did not hit upon the simple and to us obvious idea of separating the condenser from the cylinder. Yet this was not from any inability to appreciate Watt's invention, for when he saw Watt's crude idea years before it was brought to perfection, he pronounced it good, and urged Watt to make haste to perfect it, and to abandon a project for a rotatory engine with which he was then occupying himself, and which he subsequently found, as Smeaton predicted, to be useless. The fact is that the advantage of Watt's step was then by no means obvious. Watt did not arrive at it as the result of his observations on the steam-engine. It was not until he had learnt or discovered two facts in the nature of steam, of which Smeaton was completely ignorant, that he saw his way to the mechanical improvement.

Watt was aware of the fact—partly discovered by Papin, but which appears to have been lost sight of until rediscovered by Dr. Cullen—that water will boil at temperatures below 212°, when it is relieved of the pressure of the atmosphere. The knowledge of this fact led him at once to see that he could not obtain a perfect vacuum in a hot cylinder, no matter how much cold water he put into it, and hence led him to condense his steam in a separate vessel. This fact, together with the knowledge of the latent heat of steam, which he discovered for himself, although it was indepen-

dently discovered by Dr. Black, led him to his discovery. He himself says that there was an interval between the time of his being able to explain the apparent anomalies in the action of the fire-engine and his own invention.

It is usual with writers describing the history of the steam-engine to point out that in Papin's engine the boiler, cylinder, and condenser were all one, that Newcomen improved on this by using a separate boiler, and that Watt perfected it by separating the cylinder from the condenser. I would put it in another way, and say that Papin made an engine to use steam, so far as he knew its properties—those which he had discovered, namely, that water could be converted into steam, and this again condensed by cold so as to leave a vacuum—that Newcomen and Smeaton mechanically improved Papin's engine, but recognised no new properties of steam—and that Watt advanced the engine by the knowledge of the laws according to which steam condenses.

It must not be thought that I wish to depreciate the importance of the mechanical improvements which Watt effected. It is, perhaps, in respect to this part of his work that Watt stands out in the most striking contrast to his predecessors Savory and Newcomen, who but very imperfectly comprehended the facts on which they were working, while their rough and imperfect manner of putting their conclusions into practice tended, not to clear up their difficulties, but rather to confuse them. Thus they left it to Smeaton to finish their work. Watt, on the other hand, made himself master of the law of every fact with which he was acquainted, and so

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perfectly did he adapt his apparatus to his requirements that when anything did not turn out as he expected, he knew that he had got hold of a new fact. And in this way he was led from his first attempt simply to prevent condensation in the cylinder to the double-acting, expansive-working steam-engine and all its accessories—an engine which was perfect, so far as the laws of the action of steam were known to Watt. There were, however, laws very materially affecting the action of the steam-engine which were unknown to Watt.

The discovery of the principle of working expansively would have formed another epoch in the history of the steam-engine, had it not followed so very closely on Watt's first discoveries that it came to be considered as part of them. By filling his cylinder only one quarter full of steam, and allowing this to expand and fill the rest, he reduced the previous consumption by one-third, or nearly as much as he had previously reduced it by with the separate condenser. In dealing with this part of his invention he was not less careful than he had been in the matter of the previous part. Before trying it practically he investigated it theoretically, and he carefully verified his theoretical conclusions. He determined experimentally what was the best proportion in which to expand steam, saw clearly that it was only a question of balancing the gain in economy by the extra expense which the method entailed in the engine, and came to the conclusion that four times was the best ratio of expansion. This was for steam at the pressure of the atmosphere; and his method of using such steam has never been surpassed. But somehow

he failed to appreciate the fact that he had only to use steam at a higher pressure in order to extend the useful limit of his expansion. He was aware that high-pressure steam could be expanded to advantage, for in his first letter on the subject he mentions the fact;* but he could not have realised the full advantage to be gained. The fact is that, with regard to high pressures, Watt was in much the same condition as that in which Smeaton had been with regard to condensation. Although he had some of the facts before him, the advantage only became apparent on the discovery of further laws relating to steam, and these laws were not discovered until our own time.

The advantage resulting from these laws is so great, and since Watt's time so large a number of people have had to do with the steam-engine, that one would have thought they would have been discovered by mere feeling for them. But here again we see how in the matter of the steam-engine mere casual advance is an impossibility. An engine is made to use steam in a certain manner, and after it has once been constructed, there is no chance of trying any other methods of using steam in it. Thus Watt's engines "cut off" at one quarter, and no accident could make them cut off earlier. And although, as a matter of convenience, it soon became the custom to use steam at greater pressures, there was no corresponding increase in expansion, and consequently no gain in economy.

The expense of making experiments on steam-engines is very great; small engines do not answer,

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* Letter to Dr. Smale, 1769; Farey, p. 339.

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so that there is no chance of trying experiments on models; and hence no one will undertake to try a new method unless he can see his way before he starts. And the results are so complicated that on a single trial it is very possible to find an advantage where there is none, or to miss an advantage where there really is one.

The use of higher pressures of steam and greater rates of expansion was advocated even during Watt's life; but Hornblower and Woolf, who actually introduced the system, had so imperfect a conception of what they were about, and based their arguments on data so false, that they failed to establish the advantage of their method except in so far as they actually realised it. This principle, that of the compound engine, as it is now called, was found to be economical, and gradually came into use in Cornwall, where coal was dear, but it was not understood in what the advantage lay. It was supposed to lie in the high and low pressure cylinder, whereas it is really in the greater rate of expansion, and the result has been that the method, although offering great opportunities, has been neglected for seventy years, and is only now appreciated.

After Watt's time the economy of engines, as a rule, did not improve. Makers did not understand what they were about so well as he had done, and many inferior engines were sent out. However, the construction of boilers gradually improved, and this compensated for the loss in the cylinder; but, on the whole, we may say that for fifty years there was no advance, just as there had previously been no advance with the fire-engine, and that it was not until the further discoveries in the action

of steam and heat, viz. the law stated by Carnot, in 1824,* but not recognised till 1850 (by Professors Clausius, Rankine, and Thomson), after the discoveries of Joule, that the true relation became apparent, and that there was a decided step towards increasing the pressures at which engines work. During the last thirty years steam has been the subject of a great amount of philosophical research and mathematical investigation, and the theory is now a long way in advance of practice.

The relative consumption of the various engines may be stated as follows: Newcomen, 35;† Savory, 16; Watt's first, 10; last, 6; our best engines at present actually in use, 3.

The advance since the time of Watt has been chiefly effected during the last thirty years. It is partly due to the improvement in the boiler, but mainly to the increase of pressure at which steam is used. It is commonly attributed to certain mechanical contrivances, as, for instance, to the compound cylinders, because by their use one of the difficulties in the way of great expansion is overcome. Or, again, in marine engines much of the advance is attributed to the surface condenser, because by its aid salt-water is kept out of the boiler, and high pressures can be obtained without endangering the boiler from a deposit of salt. Doubtless these contrivances were necessary, and all honour be to those who have introduced them; but it is rather

* *Réflexions sur la Puissance Motrice du Feu.* Paris, 1824.

† These numbers represent the coal required to raise 192,000 gallons of water one foot, supposing the engine to be connected with a pump.

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he recognition of the importance of high pressures which has led to these mechanical inventions, just as t was the recognition of the importance of keeping his cylinder hot and condenser cool which led Watt to separate them.

This measure of improvement is at present confined to but a small proportion of the engines in use, and it only represents a portion of that which may be obtained if we may trust our calculations. At present the highest useful ratios of expansion are 10 or 15; but by going up to 100, 200, or 300 lbs. pressure, we may expand 40 or 60 times. It is true that with these higher pressures we should not obtain a proportionate result, and since the higher we go the greater will be the mechanical difficulties, there must be some point beyond which there would be no practical advantage in going. This point obviously depends on the value set upon coal.

It is not, however, simply a question between first cost and economy of working; we must remember that there are functions which the steam-engine has to perform, in which its capability, regardless of cost, is limited by the coal it consumes. The marine engine is an illustration of this. The length of the voyage from port to port is limited by the number of days' consumption which a boat can carry, and consequently it depends on the economy of her engines. Until within the last twenty years the longest voyages were to America, for although it was possible to make boats to carry more coal, they did not leave room for much cargo. By making the ships larger a greater distance could be attained: this was the origin of the 'Great

Eastern;' but this ship has proved that the useful size of ships has other limits besides impossibility of construction. Hence we may say that the length of the voyage of ships of useful size is limited by the economy of their engines. This fact has been verified, for by the recent improvements in the steam-engine, vessels of the same size as those formerly limited to 3000 miles, now steam for 9000 miles without taking coal. If the consumption of the steam-engine should be again halved, it will enable us again to double the length of our voyages, or with the same consumption to increase the speed by nearly a half.

But it is not only as regards the quantity of fuel burnt that increase of pressure affects the steam-engine—it very much reduces the size and weight of the machinery. This is in itself an advance in economy; but that does not constitute its chief importance, and in some instances a reduction of weight is obtained at a sacrifice of coal. This was the case with the locomotive, and subsequently with the portable, engine. It would have been impossible to have used an engine of the same size as the low-pressure engine for these purposes. The introduction of high pressure by Stephenson for the locomotive led to the employment of steam for an almost infinite variety of purposes to which it had not previously been applied. And there can be no doubt that any increase in the pressure, and consequently in the convenience, of the engine, would be immediately followed by an extension of its sphere of usefulness and by a consequent extension of the power of man.

As a possible limit to such extension, there is the

question of flying. The possibility of making a flying machine has been a topic so long before the world, and has been the first essay of so many philosophers, that it has come to be looked upon as a dream—as a thing to be classed with such " chimeras as perpetual motions." But this treatment is unworthy of the importance of the subject, and if we cannot avail ourselves of what is evidently nature's readiest means of locomotion, we should not rest satisfied until we know the laws which render it impossible.

Apart from the mechanical difficulties, which would doubtless be overcome, it seems that the possibility of making a flying machine depends on the relation of weight to the power. If we could make a machine sufficiently light and powerful, it would seem obvious that we could make a steam bird. Nor, so far as this is concerned, does the prospect seem hopeless.

For it is possible to make steam-engines more powerful compared with their weight than animals. It is true that, as regards economy of fuel, the horse is on a par with the steam-engine, or even a little in advance of it; that is to say, we could get more work out of a ton of hay by feeding horses upon it than by burning it in an engine. But, as regards the relation of weight to power, the steam engine is a long way ahead of the horse. An engine weighing less than two tons has done as much work as fifty horses. And it would thus seem that, since we can make an engine more powerful compared with its size than a horse, we can also make a steam bird more powerful than an eagle, and that accordingly we could make a flying machine.

This would doubtless be true if we could make small

steam-engines as economical as large ones. But this we cannot do; and even if we could, it is not our purpose simply to imitate birds, but to make a machine of sufficient size to carry at least one man; and here another law comes into play, the full importance of which does not seem to have been recognised hitherto.

This is the law which limits the size of structures according to the purpose which they have to serve and the strength of the materials of which they are composed. If we know the proportions of a structure and the purpose it has to serve, it is only a matter of calculation to find what is the largest size it can have. Except in the case of one or two peculiar forms, the weight of structures of fixed proportions increases with their size more rapidly than their strength; and hence, if a structure increases in size beyond a certain point, it will ultimately be broken by its own weight. The operations of this law are plainly seen in the works of nature; as the branches of trees grow bigger, their thickness increases in much greater ratio than their length, thus their proportions alter so as to give them a stronger form as their weight increases. The same may be seen in animals. If we compare the ratio of the thickness to the length of the legs, or, better, of the leg bones, of animals, we shall find that it increases in an obvious manner as the animals increase in size. Thus, in the mouse the ratio is much smaller than in the dog, in the dog than in the horse; but the most marked difference is seen when we come to the elephant, in which animal nature seems to have reached her limit, for if the legs were made still stronger, they would occupy

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the whole area underneath the animal.* The difference is, in truth, greater than it seems, for in the smaller animals the bones are for the most part hollow, and as the size increases the cavity becomes less, until in the elephant the bones are practically solid.

Now this limit, which seems to have been reached in the elephant, will obviously vary according to the manner in which the animal has to use its limbs. The office of merely supporting the animal's weight obviously taxes their strength much less than the duty which is performed by the wings of a bird taxes these. And it does not require much consideration to show that if the elephant is the largest walking beast that can be made out of such materials as flesh and bones, the limit for birds must be much less; some of the largest kinds weigh 150 lbs., and in this we probably see the limit which the strength of the material for the wings will allow.

A confirmation of this view is furnished by the size of fishes. Here the body is supported by its buoyancy, and although the weight may still act as a limit to size, it acts in a different way, and one which allows of the fish being as much bigger than beasts as these are than birds. Thus the largest fishes weigh upwards of 120 tons, the largest animals four or five tons, and the largest birds the twentieth part of a ton.

The same law holds in the structures made by man. Bridges and buildings all have their limit, whether it

* There are some apparent exceptions to this law, but these are the result of another law which requires short-legged animals possessing the same activity as long-legged animals to have much thicker and stronger legs.

has ever been reached or not, although these limits may be extended by altering the proportions or improving the material. The waggons and carriages which travel over ground are not much larger than the elephant; even the locomotive, which is the largest, is not so much larger, when we remember that it has six or eight wheels to compare with four legs, and moves on a smooth road instead of on uneven ground. With ships, as with fishes, the limits are much wider, and the only limit of size appears to be convenience. It would seem but natural that the analogy should hold still further, and that the possible size of flying machines should bear the same relation to that of carriages as the size of birds does to that of beasts.

It may seem, however, that we have an advantage in the strength of materials; but it must be remembered that it is strength, as compared with weight and not with size, which is of importance, and in this respect we cannot hope to rival the bones and tissues of animals. Iron is not so strong as either wood or hemp, while bone or feathers are even stronger than these. Hard steel is perhaps the strongest substance with which we have to do, but even this is no rival for the substances at the disposal of nature.

Although it does not come within the scope of this essay to enquire more exactly into these circumstances, I may state that such an examination would only confirm my conclusions. Taking into account the laws which connect the weight and power of a bird with its speed and length of wing, it does not appear that, with our present engines, we can make the wings sufficiently

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light and strong for a machine weighing two or three tons.

The margin, however, is not very wide, and the case might be altered if we could double the power of our engines, so that we may look on flying as a possible result to be obtained from the improvement of the engine. It is not a question of expense, or rivalry with other modes of travelling; should we ever fly it will be at 200 or 300 miles an hour, and this, together with there being no road to prepare, would place such a mode of locomotion beyond all comparison as to cost of machinery; and should it be possible only to carry one man, there is no doubt that there do occasionally arise circumstances, especially in times of war, when neither money nor danger would stand in the way of their usefulness.

But to return from this digression and to conclude this essay. This short review of the history of the steam-engine shows that however great may be the improvements which we anticipate, it may be a long time before we realise them, and that whenever they do come, it will not be in a casual manner, but as the result of systematic investigation, similar to that of Smeaton. The position of affairs now is very similar to what it was then. We are waiting, not for fresh discoveries, but to improve the engine up to the knowledge we possess. The question is now, however, much larger than it was then, and we should probably have to wait a long time for any one having the spirit, brains, and money to be the Smeaton of this age. No part of the improvement which may be effected can be patented, so that as soon as any one has succeeded in

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working at higher pressures, any one else will be at liberty to follow him. Hence there is no special inducement to individuals to undertake the quest. But although much time will probably pass before the task is accomplished, if it is left to individual enterprise, there seems no reason why it should not be accomplished at once, if the necessary means are forthcoming. The conclusions from a trial carrying the weight of all the theoretical and practical skill in the country would possess an authority which would ensure their speedy adoption. And the expense would not be great—nothing compared to the money which is wasted under the system of promiscuous trial hitherto followed. A mere tax on the money spent in the trial of fruitless "dodges" would defray the expense of a systematic investigation, of which the path is so clearly marked out. The very patent money which has been paid on the patents (some 3000) since Watt's time would be more than enough.

Where the money should come from is no great matter, —there are many legitimate sources. It might come from the railways, whose interest is represented by some two millions odd tons of coal burnt yearly; from the steamboats, which burn three millions odd tons; from the manufacturers, who burn twelve millions; or it might come from the purse of the nation, which has an interest in all its coal, besides itself consuming some 300,000 tons yearly for its navy. It might come from any one of these sources, or from all combined. And there is yet one other source from which it might come with a singular appropriateness, and this is the institution of which Smeaton is the father—an institution which

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has a large surplus of money at its disposal, for which it could hardly find a more honourable or appropriate object.

Whatever is done, however, should be done quickly. For the present high prices of coals are causing the worst engines to be replaced, and after the change has once been effected, whatever further improvement may ensue, the chance of its immediate introduction will have been lost.

OSBORNE REYNOLDS.

VII.

Primeval Vegetation in its Relation to the Doctrines of Natural Selection and Evolution.

No publications that have been issued in modern times have produced so wide-spread a commotion in the scientific world as those embodying the allied doctrines of Darwin and Herbert Spencer in relation to the origin of species. The only approach to a parallel must probably be sought either in the appearance of the botanical system of Linnæus and the promulgation of his views respecting the sexuality of the vegetable kingdom, upon which that system was chiefly based, or in the controversies of the Plutonists and Neptunists that followed the rival teachings of Hutton and Werner. The doctrines of Evolution and Natural Selection have divided the scientific world into two opposing camps; but the contending forces are scarcely equal. The advocates of the new views are ardent and energetic—full of faith in the soundness of their fundamental ideas, and treating with ill-concealed contempt anyone belonging to an older scientific school who is unable to travel along the new road with their vigorous steps.

The assumption that the combined doctrines of Natural Selection and Evolution furnish the sole clue to the origin of species, derives much of its popu-

larity from the fact that they do unquestionably account, in a satisfactory manner, for many phenomena that have hitherto received no other adequate explanation. These doctrines undoubtedly explain the origin of what have hitherto been termed varieties, while it is equally certain that many of these varieties are wholly undistinguishable from what we designate species. It is also true that in many instances generic types appear to merge in each other in such a way as to make it difficult to define their boundaries. But we must not be driven by this difficulty to the hasty acceptance of conclusions which involve other difficulties equally great and far more serious in their ultimate issues. As furnishing the probable explanation of many perplexing phenomena, the new light is of the highest value; it is equally so in supplying a tentative guide as well as a stimulus to fresh researches. Unfortunately the man of science is not like the tunnel-constructing engineer. The latter can measure the lengths and heights of the otherwise unknown masses which he designs to penetrate; and he can define the exact point at which he will emerge into daylight, fully assured that the results will accord with his pre-conceived plan; but the scientific explorer, having no such definite guides as the theodolite and the measuring-chain, must fall back upon the more uncertain aid of hypothesis to direct his efforts to penetrate the unknown. But this auxiliary must be his servant, not his master, holding office subject to dismissal the moment its further employment is incompatible with the service of truth.

Notwithstanding the extensive literature which the

new doctrines have called into existence, there is one important branch of enquiry which has only received a limited amount of attention in connexion with them. The animal kingdom has been widely and deeply studied in reference to the question at issue. Not only living, but extinct, animals have been appealed to; Professor Huxley especially has, with his wonted skilfulness, made use of the latter to buttress the geological side of the structure, which is confessedly its weakest one. But the extinct vegetable kingdom has been comparatively neglected in connexion with this subject. Dr. Dawson has examined it to some extent in its relation to the doctrine of evolution*; but, with this exception, it has only attracted the attention of the numerous disputants in a very limited degree. Yet the study of palæontological botany offers many advantages, which render it an important factor in the enquiry.

In the case of the extinct animals, the palæontologist rarely possesses any of their remains except their hard tissues, such as the bones, teeth, and horns of the vertebrates, and the hard dermal tissues of the invertebrate animals. It is true that he can infer from these what some of the soft tissues were probably like; but palæontology reveals so many strange and unexpected combinations, that much care is needed in admitting such correlations as Cuvier taught us to seek. They must always be received with some measure of doubt, especially in the case of animals which have aberrant

* *The Fossil Plants of the Devonian and Upper Silurian Formation of Canada*, 1871. *The Story of the Earth and Man*, 1873.

[illegible]

[illegible] organs [illegible] cones. [illegible] becomes [illegible] evolution [illegible] the notice of the [illegible] to the many imperfections of its testimony, I propose to attempt to ascertain what is the evidence it is likely to furnish.

But before entering minutely into the details of the question, it may be well to take a bird's-eye view of the area over which we are about to range, and at the outset I would fully recognise the exceeding improbability of our having yet found the earliest traces of vegetable life upon the globe. The ages during

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which the vast piles of Laurentian strata were being accumulated appear at present to have left no trustworthy traces of their vegetable life. The same remark is applicable, if we except some very dubious elements, to the Cambrian and Lower Silurian deposits. Marine Fucoids doubtless must have existed in those days, to supply food for the numerous vegetable feeders among the mollusks and crustaceans which constitute so large a portion of the primeval fauna; but no terrestrial plants have hitherto been discovered in these ancient beds. The sudden way in which the vegetation of the Palæozoic ages bursts upon us during the Devonian period, inevitably suggests the probability of a pre-Devonian terrestrial flora, which has yet to be discovered; but, in endeavouring to learn what geology actually teaches respecting the doctrine of evolution in its relations to vegetable life, we must not indulge in surmises as to what may have been; we must take such facts as exist, with all their imperfections, and restrain our inferences within such limits as those facts obviously justify. What the actual value of geological testimony in relation to this problem may be is an open question. I am well aware of the many imperfections in the geological records—of the many gaps in that history of ancient life which geology alone makes known to us; but, imperfect though the testimony is, it is less so than that of any other witness, for the simple reason that here only can we see the experiments by which the doctrine of evolution must be tested carried on through such long periods of time as are necessary for leading to trustworthy conclusions. It is to the slow action of external forces, acting through countless ages,

that the evolutionists appeal in explanation of their hypothesis. The brief periods during which human experiments can be carried on are altogether insufficient to test the durability of any results that may be obtained. Even the oldest historic records represent durations of time which are insignificant in the eyes of the evolutionist. Hence, unless he appeals to the geological records for experimental evidence of the truth or error of his hypothesis, the latter becomes merely an ingenious speculation, resting upon no adequate basis of facts. To adopt it would accordingly be to return too nearly to the unprofitable processes of the schoolmen, instead of adhering to the inductive methods in which the experience of the last two centuries has taught us to trust. Whatever, therefore, may be the imperfections of the testimony which they afford, the rocks must be our chief witnesses in any final court of appeal.

While affirming this, I am aware that Mr. Herbert Spencer denies that such is the case: he says "the hypothesis of evolution, then, has the direct support from facts which, though small in amount, are of the kind required, and the proportion which those facts bear to the conclusions drawn seems as great as is the proportion between facts and conclusions which in another case produces acceptance of the conclusion."* Mr. Spencer's reference is to our acceptance of the evidence that the physical forces now in action are competent to produce all the known effects seen in the structure of the earth's crust. I cannot accept his inference that the conditions of the evidence are equal

* *Principles of Biology*, vol. i. p. 353.

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in the two cases. The differences between the physical results now being produced by existing physical forces and those produced in pre-historic ages are merely those of degree. The earthquake which raises a given area a few feet above its former level only requires to be repeated sufficiently often, to raise a mountain chain, like the Andes, out of the depths of the sea. We see that such shocks produce such successive elevations, and we find evidence, in the structure of the mountains referred to, that they have been so uplifted. The last shock may be an almost exact repetition of the first, without the necessary introduction of a single new factor; and, which is important to the argument, we have evidence, independent of opinions derived from mere hypothetical reasoning, that the elevation of the Andes does not exceed the limits within which existing volcanic forces are known to be capable of acting. But in the organic world the reverse is the case. The doctrine of evolution not only involves the possibility that the incident forces constituting the factors have been liable to be changed in their character, but actually demands as a primary necessity that such changes should have been introduced. Were such not the case, evolution would, on the avowed principles of the evolutionists, be absolutely impossible. Let the factors remain the same, and however frequently their action might be repeated, the only result would be a cumulative multiplication of *like* effects: a moss would remain a moss to the end of time, though in the interim it might have spread from a central point, until it clothed an entire mountain with a verdant robe. The uniformitarian in geology insists upon the occurrence of suc-

cessive repetitions of *the same* agencies and upon their necessary reproduction of the same effects; whereas the introduction of *new* agencies, or at least of new combinations, is essential to the conceptions of the evolutionist. There is no reason for doubting that, when changes occur in the external forces which affect an organism, the form and structure of the latter must become modified, however imperceptibly, in order that it may be adapted to its new surroundings. If it is incapable of undergoing the necessary modifications, it perishes; if it can undergo them, it survives as a new variety of an old form. But we have no evidence that this potentiality for modification is unlimited. Neither have we any proof that there is no choice except between the alternatives of continuous change *in one direction*, or of death. Mr. Spencer argues that, since the possibility of variation occurring in the incident forces must be unlimited, there can therefore be no limit to the possible resultant modifications of the organism. That the surrounding conditions may be liable to constant change is undoubtedly true; but it does not follow that such changes must be so continuously in one direction as necessarily to cause a perpetually-increasing divergence of the organism from its primary type, whether upwards towards a higher, or downwards towards a lower, form. They may occur as an endless series of oscillations within definite limits, like those of a pendulum which has been made capable of changing both the lengths and the planes of its oscillations, yet never moves far from its static position. The known phenomena of the living organic world afford, and can afford, no proof that unlimited

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changes are possible, because we cannot watch them through periods of time sufficiently long to afford the proofs required. We merely know that, by the limited action of the processes represented by the terms evolution and natural selection, new varieties, which may or may not attain to the rank of species, are produced, and that these may even be perpetuated through long periods; but what we want is evidence that organisms ever actually differentiate into types so distinct from one another as a Phanerogamous plant is from a Cryptogam, or a pine from a Lycopod.

It would be easy, if space allowed, to develope this argument; but I have said sufficient to show what are the grounds upon which I demur to what appears to me the weak point in Mr. Spencer's otherwise admirable work—a work of which it is difficult to say whether the clearness of the style, the general logic of the argumentation, or the bold grasp of the subject deserves the highest praise.

In appealing to geological testimony, I do not forget that its broad features have already been examined by Mr. Spencer, and his acknowledgment that such testimony proves very little either for or against his argument. Not that he under-estimates its possible importance, but he considers the geological record too imperfect to supply us with all the facts necessary to enable us to read between the existing lines of nature's book. He lays down, however, the general proposition that, where the successive groups of strata called formations pass into each other continuously and without any indication of a material disturbance of, or break in, the chronological series, we may expect to find evidence

of a gradual change in the organisms. I have already admitted the imperfection of the geological record; nevertheless I am disposed to attach a higher value to what remains than Mr. Spencer appears to do. Besides, in several parts of the globe, we have important instances of transitional strata linking together distinct formations, under conditions approximating closely to those suggested by Mr. Spencer. Thus the tile-stones connect the Silurian with the Devonian strata; the Rhætic beds of the Eastern Alps join the Triassic with the Liassic series; the Speeton clay of Yorkshire is a continuous blue clay, the lower part of which is Oolitic and the upper Cretaceous; and the interval between the Cretaceous and Eocene Tertiary series is partly bridged over by the Mæstrich and Faxoe deposits, by the Thanet sands and by the lowermost Tertiary beds of Belgium. In these examples there occurs either an overlapping of the life of two periods, causing an intermingling of the faunæ of two ages, as in the Rhætic and Mæstrich examples, or there is an undisturbed physical transition from one formation to the other, while the boundaries of the corresponding faunæ are as distinct as they are in other localities, where physical disturbances have caused inconformity between the two formations. We have an example of the latter class of facts in the Speeton clay of Eastern Yorkshire just referred to. The greater portion of its blue clay belongs to the Neacomian series, but its base is Wealden. The transition from the lower to the upper portion of this deposit has been effected without the intervention of much, if of any, physical disturbance. The conspicuous break in continuity which so often occurs where

the Cretaceous beds rest upon the Oolites, has been produced in this district, not at the time of transition from the one formation to the other, but after all the lower Cretaceous or Neacomian beds had been deposited, previously to the formation of the true chalk; hence the latter alone rests inconformably upon the Oolites. Here, at all events, we have a locality favourable to the preservation of the transitional organisms of Mr. Spencer's hypothesis; but do we find such? Nothing of the kind exists; the characteristic oyster of the Wealden* with its associated brachiopod,† here gives place, as we ascend through the clay, to the Neacomian Gryphæa,‡ as it does in other parts of the kingdom, where the physical conditions are altogether different.

A yet more striking example presents itself in the Foraminiferous ooze occupying the warm areas of the bed of the Atlantic. While rejecting the idea that we are in any proper sense living in a Cretaceous age, there is no reason for doubting that the deposits in question have been accumulating undisturbed ever since the time when our European chalk strata were continuous with, and formed part of, them. I will not demand that the *Challenger* should bring back recent examples of the Cretaceous Saurians and Ganoid fishes; but where are the transmuted descendants of the Cretaceous mollusks? A stratum which has undergone so little change of physical condition as to have allowed the retention of Cretaceous types of sponges and Echi-

* Ostrea deltoidea. † Rynchonella inconstans.
‡ Gryphæa sinuata.

noderms, ought also to have retained some, at least, of the numerous Cephalopodous and Lamellibranchiate shells, since we have no reasons for supposing that the latter were not quite as capable of enduring slight changes in their environments as the Echinoderms that have survived. In an area which has obviously undergone very slight physical alterations, had no other and unknown force intervened, we should have expected to see abundance of Ammonites and Belemnites, of Hamites and Scaphites, of Inocerami and Plagiostomæ; or at least of forms which have varied so slightly from the above types as to indicate clearly a direct descent from them. But nothing of the kind exists; on the contrary, non-Cretaceous mollusks were found to be common to the warm and cold areas to an extent which the conchologists who explored the Atlantic were unprepared to expect, and afforded no indication whatever that they had descended from special Cretaceous types. Some far more radical cause than the "slight change" of Mr. Spencer is required to account for these biological phenomena, though in all probability the actual physical alteration which has occurred in the condition of this Atlantic sea-bed has been as "slight" as it well could have been to constitute a change of any sort.

I will not attempt to speculate upon what may have been the flora of the Silurian, Cambrian, and pre-Cambrian ages. All that we know of the matter is, that a few remains occur here and there in the rocks of those ages which are believed by some palæontologists to have been Fucoids. In the uppermost of the Silurian series a few spores and other fragments have been found, which may possibly have been Lycopodiaceous

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We first come into contact with vegetation in definite shapes in the Devonian strata, the magnificent flora of which period, as it existed in New Brunswick, has been made known to us through the labours of Dr. Dawson and the officers of the Canadian Survey. I need not dwell upon that flora, because, with the exception of one remarkable genus of plants,* supposed by Dr. Dawson to be Lycopodiaceous, it corresponds in a very close manner to the flora of the Carboniferous age, with the general features of which all geologists are familiar; the two bearing a striking resemblance to each other, not only in the general types of vegetation, but even in their constituent genera. In the magnificent forests which obviously existed in those ages, a few grand arborescent types must have preponderated so largely as to give to each sylvan scene its characteristic physiognomy; but mingled with these dominant forms were others that must not be overlooked.

The most conspicuous of the Devonian and Carboniferous plants were unquestionably gigantic Lycopods—now represented by the dwarfed club-mosses which creep along the turf of our grassy uplands, or fringe the footpaths which intersect the solitudes of Brazilian forests. Along with these were Calamites—huge representatives of the modern Equiseta or horsetails; some trees which, so far as their general structure was concerned, approached closely to our modern pines and Araucarias; and, finally, a rich undergrowth of ferns, which, in some instances, rose up into arborescent forms like the tree-ferns of the present time. Whilst

* Psilotum.

the above were doubtless the most conspicuous of the Palæozoic plants, we shall have to note the existence of some others of doubtful character, which may bear upon the question under discussion, and which consequently demand more minute examination.

Ascending from the platform of the Carboniferous strata, we reach the Permian rocks—in which we still find the Carboniferous type of vegetation to be prevalent; indeed, had it been possible for an observer to have seen the forests whence came the plants found in some of the Permian strata of Russia, he would probably have detected no obvious difference between them and those of the Carboniferous age. On the other hand, in the strata of Thuringia and Lodeve we have indications of fewer gigantic Cryptogams and of more plants whose affinities were obviously Coniferous*—changes indicating a nearer approach than the Carboniferous plants presented to those of the Oolitic age.

Rising still higher in the scale of strata, we come to the Triassic series, in which the vegetation exhibited so marked a change, that it is regarded by Brongniart as representing the commencement of what he designates the "*Règne des Gymnospermes.*" The huge Lycopods and Calamites now either wholly disappear, or are represented so feebly as no longer to affect the physiognomy of nature. Ferns clothed the ground with undergrowth, but the forests themselves chiefly consisted of Coniferous and Cycadean plants, intermingled with a few that may possibly mark the advent of the

* Walchia and Cryptomerites.

Monocotyledonous type of vegetation, though as yet this is a very doubtful point. In the Keuper, the uppermost member of the Triassic series, these changes become yet more marked, especially in the substitution of true Equiseta for the Calamites of older days. Traces of the latter still linger in some Triassic rocks near Stuttgart, but these indicate a dying effort; they now vanish finally from the flora of the earth.

The Liassic[*] and Oolitic strata may be viewed together, since they furnish one great identical flora. The change from the Palæozoic types, for which the Triassic age had prepared us, is now complete. The Lycopods exist, but they are few in number and dwarfed in size. They have been quite as insignificant as those now living. They appear to have crept along the ground, half-hidden by a dense carpet of ferns intermingled with clumps of Cycadean plants and of noble pines, resembling the Araucarias of the present day. Unlike the apparently Coniferous stems of the coal measures, the true nature of these Oolitic pines is not a subject of doubt, since we now find fossil cones, proving that at least some of them have been truly *Gymnospermous* exogens, as well as possessed of an exogenous stem. True Equiseta are now the sole representatives of the Equisetaceous family, while the flowering forms are limited to a few curious aquatic

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[*] If the anthracite beds of the Alps belonged to this series of rocks, as is believed by some geologists, the following paragraph would require to be materially altered; but Professor Heer has given excellent reasons for believing that those beds are carboniferous. See *Quart. Journal Geol. Soc.* vol. vii. part ii. p. 91.

plants, such* as Potamogetons, from the Lias, beyond which they are very doubtfully represented by a few grass-like objects from Bayr and some fruits from Malton.† The Cretaceous age brings with it new changes, accompanied by a retention of old types. The conspicuous features of the Oolitic flora not only linger, but in some localities continue dominant. But in other areas, new types, belonging to the Angiospermous, or flowering division of plants, unquestionably make their appearance. Ferns, pines, and Cycads continue to be prominent, both from their individual numbers and, in some cases, from their magnitude; but associated with them we now find the representatives of the willow and the alder, of the maple and the walnut, in addition to some remarkable leaves from Blankenberg, the earliest of all known Dicotyledonous forms, and to which Zenker has given the name of Credneria.

The Cretaceous period constituted a bridge connecting the Oolitic with the Tertiary age. The flowering plants just mentioned constituted part of an advanced-guard, followed by the main army of similar plants which deploys rapidly before our view during the Tertiary period. Even the oldest of the Eocene

* Mr. Sorby has described a fragment of wood which appears to have belonged to a non-Gymnospermous exogen from the Lias: but having been purchased from a dealer, its source is not to be relied upon.

† Besides the above Naiadites, Professor Buckman notices Umbelliferæ and Ericaceæ; but as the former is described from a single seed and the latter from a solitary leaf, the evidence respecting them is as yet insufficient to justify an acceptance of them as true flowering plants.

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strata abound both in Monocotyledonous and Dicotyledonous Phanerogams, whilst the Cryptogamic forms retreat into that comparative obscurity which marks their position at the present day. We now discover that even the cellular Cryptogams are as capable of mineralisation and permanent preservation as the vascular types. We find examples of sea-weeds and fungi, liverworts, mosses, and Charas associated with ferns and Equiseta. A Coniferous flora continues to be conspicuous; and side by side with lofty pines we have true palms, which prepare us for the advent of the gorgeous tropical vegetation of the present day. This gradual approximation of the past to the present becomes increasingly marked when we reach the Myocene deposits; and on glancing at a list of the Pliocene genera of plants, so vast a number of familiar names strike the eye, that we might easily suppose ourselves to be reading a report on the existing flora of a German forest, or of the wooded banks of the Mississippi.

The preceding sketch will probably enable even the uninitiated reader to apprehend the essential elements of the problem to be solved, and also what appears to be its only possible solution. One great truth stands out conspicuously—the importance of which has been already insisted upon by Professor Huxley and admitted by Mr. Herbert Spencer—viz., that no theory of evolution will be admissible that does not account for two apparently opposite phenomena, viz., the persistency of some types and the gradual introduction of new ones. Thus there is no question but that in the case of three prominent groups of Carboniferous and

pre-Carboniferous plants—viz., the Lycopods, the Calamites, and the ferns—we have representatives of well-known living types taking the place of those types themselves in the primeval world. The first great question is,—What relationships subsist between the old and the new forms? Are the former the ancestors from which the latter have descended by direct lineal descent,—or have the living ones, which occupy the social position and display the emblazonments of the dead scions of other stocks, stepped into the places of the older types?

Supposing this question to be determined, there arises a second one, viz.,—What relationships subsist between this ancient Cryptogamic flora, at once so magnificent in its general aspect and so little varied in its characteristics, and the far more diversified types of plant-life which now clothe the earth with verdure? Have the direct descendants from the ancient species degenerated and sunk into obscurity, like Hugh Miller's Earl Crawford, who carried hods of mortar? Or have they, on the other hand, ascended into higher ranks in the scale of organisation, leaving their former places to be occupied by aspirants rising from a yet lower level? Three solutions of this question alone appear probable:

1. The almost wholly, if not absolutely, Cryptogamic vegetation of the earlier ages was the direct ancestral source of the present Cryptogamic vegetation, but of no other; the latter being derived from the former through an unbroken lineal descent. In this case, variations representing genera and species may have been produced by the action upon successive generations of

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:ident forces which constitute their environments, so at many of the descendants differ widely in points detail from one another and from their common ncestors, without departing entirely from the features ssential to the primary type. Of course this explanaion leaves the introduction of new types unaccounted or: or, in other words, involves new and successive reations by some external source of power: as similar reations seem requisite to account for the primary origin of the Carboniferous types themselves.

2. *All* the primeval Cryptogamic plants may have undergone successive developements, in the course of which they exchanged the Cryptogamic for the Phanerogamic form. If this process of transmutation from one type to another was possible in any degree, no limit need be placed upon our estimate of what it could accomplish. A single primary atom of protoplasm might, by a continuance of this transmuting action, become the parent of the entire vegetable kingdom. But this hypothesis involves the supposition that the incident forces, which occasioned the upward developement of each organism, affected equally the entire vegetable world. As Thallogens ascended into vascular Cryptogams, vascular Cryptogams became Phanerogams. But whence, on this hypothesis, came the existing Protophytes and Thallogens? To account for them we require a perpetual renewal of the primary genetic atoms, whatever they may have been.

3. A combination of the processes enumerated in the three preceding paragraphs may have occurred. Assuming the unexplained existence of a primary germ capable of self-multiplication, we obtain a primeval

supply of protoplasmic atoms, which may have b the ancestral roots of all existing vegetable pr plasms. But while some of these germs may h undergone developement into higher forms of plant- thus producing new vegetable types, others may h continued to reproduce their likes, or at the utr may have reproduced mere varieties of their own t which latter may have continued persistent througl all time. This hypothesis assumes that whilst s organisms have been exposed to the action of alt external conditions, which first disturbed their funct and subsequently altered their structure, bringing t into equilibrium with their new surroundings, o similar organisms have remained wholly or comp tively unchanged, because their environments l continued to be virtually the same throughout all ti but we must here recognise three possible directior which those organisms which underwent changes, sequent upon the incidence of new forces, may l been modified; all such changes must have been ei upwards, into higher types—downwards, into lc ones—or some upwards and some downwards.

Substantially this third hypothesis is that of Herbert Spencer and the evolutionists; the downv or retrogressive evolution being especially insisted u by Mr. Wallace. In appealing to the rocks to fur a solution of the problems suggested in the al paragraph, it appears to me that the more anc strata present the factors in the problem in a n simple form than the strata of later age. instance, in whatever part of the globe we examine Carboniferous rocks, we see that the types of vegeta

of which they furnish examples are comparatively few in number, contrasted with what we find in rocks of newer date. The same contrast is seen, though in a different degree, in the Mezozoic Oolite strata. Not only was this the case, but the plant-life of the Palæozoic world was more uniformly cosmopolitan than it is now. It consisted solely of Cryptogamic plants intermingled with some modified forms of the Coniferous type. In dealing with the animal kingdom, Professor Huxley especially contends, very properly, that the absence of the remains of certain animals, the higher vertebrates, for example, from the older strata, is no proof that such animals did not exist in those ancient times; but only that they did not exist in the particular submerged area to whose deposits we now have access. But I think that the peculiarities of the Carboniferous vegetation cannot be explained in this way. If Dicotyledonous or Monocotyledonous trees existed in any part of the globe at the Carboniferous period, why were they excluded from the numerous Carboniferous forests, with the remains of which we are now familiar in various localities, ranging from Spitzbergen to Australia? Economic reasons have led to a more general investigation of the Carboniferous strata than of less valuable deposits. It seems almost impossible that we should have been so unfortunate as everywhere to have dipped into these strata where Carboniferous Cryptogams and Conifers alone had grown, missing with equal uniformity all the areas upon which flowering plants had flourished. This might have been supposed possible, had our knowledge of the Carboniferous flora at remote points of the earth's surface been as limited

as it is in the case of the Oolites. Under existing circumstances the doctrine of chances alone militates against such a conclusion.

We know of no living forests in any part of the globe, which are exclusively composed of Cryptogamic and Coniferous plants, least of all in tropical and semi-tropical zones. Such forests everywhere abound with Monocotyledons and Dicotyledons, either arborescent or herbaceous. Yet I think we may rest assured that we have in the Carboniferous rocks a fair representation of what grew in the Carboniferous forests. When a continent was slowly undergoing submersion, the land animals could retreat before the rising waters, and even the marine ones could emigrate if the new conditions became unpleasant to them; but the plants, rooted and fixed in the ground, could do nothing of the kind. The larger trees, especially, not being liable to removal by the currents, remained where they grew, as we find they have done in numerous instances in both the Old and the New Worlds; but had even the smaller herbaceous Dicotyledons formed an undergrowth flourishing side by side with the smaller ferns that grew under the shade of the Lepidodendra and Sigillariæ, some traces of them would have been found amongst the innumerable fern-fronds with which our coal shales are loaded.*

* Though the animal kingdom forms no part of my present subject, I may be permitted a reference to one important fact that has not hitherto been explained. Even the Silurian rocks furnish remains of sharks—the highest order of fishes—and the Devonian and Carboniferous strata abound both in similar remains and in those of the Ganoid type; but nowhere below the chalk do we find a single true scale of the types known as Cycloid and Ctenoid—types which,

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We have, therefore, I think, exceedingly strong evidence that Dicotyledonous plants had no existence during the Palæozoic epoch, and, unless we find true cones belonging to the reputed Conifers of the same epoch, there must remain grave doubts whether flowering plants of any kind had then made their appearance upon the earth; because the stems alone are not infallible guides as to the systematic position of the plants to which they belonged.

If the above arguments are valid, it follows that, while we are ignorant of the vegetation of the Laurentian

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whether we take the organisation of the scales themselves, or that of the nervous systems and reproductive organs with which those forms of scales are associated, occupy a much lower position as to organisation than the sharks, whilst they are certainly not more highly organised than the Ganoids. Indeed, so far as their respiratory organs are concerned, the latter fishes approach much nearer to the amphibia than do any of those with cycloid or ctenoid scales. Yet, though low as to organisation, these latter fishes only appear at a late period of the world's history. Mr. Spencer's favourite resource of migration will scarcely account for their first appearance during the Cretaceous age. It would be impossible to find either sea, river, or lake from which such fishes are excluded at the present day; and as the continuous ancient seas always afforded facilities for free migration, such as might not be available to animals living upon detached islands and continents, it seems to me a physical impossibility that some traces of these fishes should not have been met with in some of the older rocks, had they existed at the time in which these rocks were accumulated. If they originated through evolution, these modern fishes must either indicate an evolution of higher forms into lower ones, or of lower non-vertebrate creatures into vertebrate fishes. But here we encounter new difficulties. The various parts of these organisms have developed unequally, *e. g.*, the skeletons of Cycloids and Ctenoids are much more highly organised than those of sharks, but this order is reversed in the case of the nervous systems of the two types: a combination of ascending and descending conditions in the same animal which I have not yet seen explained.

age our acquaintance with the earth's flora substantially begins with that of the Devonian epoch, when we first meet with it in a much lower degree of developement than is the case with the animal kingdom of the same age. We have already seen that not only was the highest division of the animal kingdom, that of the Vertebrata, represented long before that period, but that it was represented by the sharks, the highest modification of the Ichthyal division of that kingdom. And, on reaching the coal measures proper, we further find true amphibia in addition to the fishes, while the vegetation continues to be virtually unchanged, retaining the same archaic features which characterise that of the Devonian rocks. Hence I conclude that, for the purpose of testing the doctrine of evolution, the geological record is less imperfect botanically than zoologically, since we practically catch the vegetable kingdom at a comparatively early stage of its history, and are able, in some measure, to trace its upward progress.

In England we commence our acquaintance with the plant life of the globe through some Lycopodiaceous stems and a few doubtful spores found in the Upper Silurian strata of Europe, and in America with a few fragments of plants of the same age, to which Dr. Dawson has given the name of Psilophyton. These latter plants, which Dr. Dawson regards as Lycopodiaceous, have been found in the Upper Silurian strata of New Brunswick, and yet more abundantly, and in a better state of preservation, in rocks of Devonian age in the same region. Some are of the most [illegible] [illegible]

organisation and its relations to other plants. Dr. Dawson has answered these enquiries for us, and I think there is little doubt respecting the general accuracy of his conclusions. The plant was Lycopodiaceous, having a central axis of barred vessels, surrounded by a bark composed of an inner layer of Parenchyma and an outer one of elongated Prosenchyma. This is virtually the organisation of many of the living Lycopods, as it was of many of the arborescent forms with which Psilophyton was associated. We are thus first introduced to terrestrial plant-life in a form which, for a Cryptogam, exhibits a high degree of organisation.

In the Devonian age vegetation bursts upon us in a startling manner. We suddenly find ourselves surrounded by magnificent examples of a forest flora. Dr. Dawson has supplied abundant evidence that those arborescent Lycopods, the Lepidodendra, prevailed during the Devonian period. But this genus also existed in the Silurian age;—at least one of the plants just referred to, and which occurs, according to Geinitz and Barrande, in the Upper Silurian strata of Lobenstein and Hostein in Bohemia, is said to belong to it. In the Devonian strata of New Brunswick we also have Sigillariæ: a genus, the European examples of which were unquestionably gigantic arborescent Lycopods, but the Canadian forms of which are believed by Dr. Dawson to have had a yet higher organisation. Though some of the latter are small, others have been found of large size; while large Stigmariæ, the undoubted roots of Lepidodendroid and Sigillarian stems, have been found in the Devonian beds of Kiltorcan

in Ireland leaving no room to doubt that even during the Devonian epoch the Lycopodiaceous type of plant had assumed an arborescent form and a high organisation. But it is when we reach the Carboniferous age that we learn what these arborescent Lycopods really were. We now find them possessed of gigantic stems, sometimes with a circumference of twelve feet. On turning to their well-understood organisation we discover that it is much higher than what exists in any living Lycopod. The central vascular bundle of the living type expands into a hollow cylinder, enclosing a large pith, whilst on its outer side there developes a succession of concentric vascular layers, arranged in radiating wedges and separated by true medullary rays, the whole closely resembling the arrangements of the tissues in the stems of some exogenous Phanerogams, whose processes of genetic activity these Lycopodiaceous stems closely imitate. We thus find in these huge Cryptogams a high degree of internal organisation, to which their living allies present no parallel. Both in magnitude and in the complexity of their structure they rival the more highly-organised forest trees of modern times. But whither do these facts lead us? When I first became familiar with them, I was almost tempted to believe that these plants constituted a transitional group of cryptogams which were in process of developement into some higher type of exogenous vegetation. They seemed to be bursting the bonds that held them within the limits of the Cryptogamic group, and I should not have been much surprised had I discovered similar forms in strata still newer, but which had cast aside their sporangial fructifi-

cation and produced in their places the stamens and pistils of the Coniferous flowering plants. But no evidence of such a transition has yet been discovered.*

* Before we can judge accurately how far such a change as is here referred to is possible, it is necessary to accomplish the very difficult task of establishing some parallelism between the reproductive organs of such plants as occur in the Palæozoic rocks and those of the flowering plants. In the ferns, the Equiseta, and many of the Lycopods, a spore germinates into a small cellular "prothallus," in which germ-cells, and often sperm-cells also, are developed. This Prothalloid stage, in which the organism does not contain a single vessel, represents a very low type of vegetable organisation. Its germ-cell, variously fertilised by antherozoa in different plants, soon developes into a true vascular plant, and the cellular prothallus from which it sprang, having fulfilled its function, perishes. This prothallus thus reminds us of the *Pluteus*, or larval condition of the Echinodermata. In each of these cases the cycle of life from germ-cell to germ-cell equally embraces two very different stages of existence, which appear to represent two generations of individuals, the one sexual and the other sexless; only the conditions are reversed in the two cases. In the plant it is the earlier and less highly-organised form that is the sexual condition; in the animal, on the other hand, the Pluteus is sexless, reproduction being effected by the matured Echinus, or starfish, which buds from the Pluteus. It is this dual condition of the vegetable type which renders it so difficult to see the possibility of the Cryptogams which exhibit it ever being evolved into any of the flowering plants, in none of which it occurs. I can but see one way in which, by the utmost stretch of the imagination, such a transition could be deemed possible, viz., to regard the prothallus of the fern, which bears both germ and sperm cells, as representing an anther blended with the nucleus of an ovule; whilst in the monœcious forms, such as the Selaginella, these two elements are separated, as macrospores and microspores, though associated on the same spike of fructification. If this hypothetical homology has any foundation in truth, the first step that would be required to convert the Cryptogram into a rudimentary Phanerogam would be that the macrospore of the Selaginella should develope into a prothallus without becoming detached from its parent spike, or strobilus, and whilst in that state should have its germ-cell fertilised by the antherozoon. We should thus obtain the primary condition essential to our idea of a flowering

These Lycopods attained their grandest aspect in the Carboniferous age, soon after which, instead of developing into something yet higher in the scale, they rapidly declined. It appears to be a fact that, in almost every age of the world, some one or more of its plants or animals attained to unusual and almost incredible dimensions. In the Silurian and Devonian ages the races thus dominant were the Cephalopods* and the Crustaceans.† In the Carboniferous age these unwonted dimensions were seen in the Cryptogamic members of the vegetable kingdom. In the Triassic period the Batrachians ‡ take the lead, to be displaced in the Oolitic epoch by the giant Saurians. Still later the Cretaceous rocks reveal Pterodactyles—true flying

plant, viz., that these processes should take place in the matured, rather than in the immatured, condition of the organism. I have referred in another part of this Essay to the circumstance noticed by Henfrey and others, that a remarkable resemblance exists between the developement of the embryo in Selaginella and in some of the Coniferæ, a co-ordination of fact with hypothesis. We might, by a liberal indulgence of the imagination, conceive it possible for a Cryptogam to be evolved into a Phanerogam through one or other of the above-mentioned Carboniferous types. But, so far as the coal-plants are concerned, we have, unfortunately for the hypothesis, the clearest proofs that no process of the kind referred to took place. The spores were detached from the strobili of the most arborescent of the Lepidodendra, exactly as they are from those of the smallest of the living Lycopods. If the Carboniferous Dadoxylons were true Conifers, they would be appealed to by the evolutionists as the probable line through which the descent of the Phanerogams from the Cryptogams is to be traced. I have already pointed out that we know nothing of the origin of these Dadoxylons, because they already existed in their highest perfection when the earliest of the known plant bearing strata were deposited. But, however far we have to go back in search of their origin from Cryptogamic types, the above argument remains applicable to them.

* Orthocera. † Eurypterus. ‡ Cheirotheria.

dragons, stranger than those of Eastern fables, measuring more than twenty feet from wing to wing. In the older Tertiary seas the sharks became the dominant monsters, eighty or ninety feet in length. Then the tortoise of the Himalayas,* and the armadillos † and sloths ‡ of South America assumed giant forms. As all these passed away, or rather assumed the dwarfed dimensions of their modern representatives, a new mammalian race came to the front. It was foreshadowed indeed during the Tertiary age, but, unlike many of the other monsters referred to, it still survives to

> "Tempest the ocean. There Leviathan,
> Hugest of living creatures, on the deep,
> Stretched like a promontory, sleeps or swims,
> And seems a moving land."

I need scarcely say that mere bulk usually tells us nothing of a creature's position in the scale of organisation. The most gigantic Ichthyosaur is less highly organised than the little lizard which darts through our stone heaps and basks upon our walls. But in the case of the giant Lycopods of the coal measures, increase of bulk *has* been accompanied by a more complex organisation, so far as the vegetative organs were concerned; but as we travel upwards we shall discover no evidence that this higher organisation led to any ulterior results tending to sustain the doctrine of evolution.

The flora of the Permian age is but little known, sufficient, however, has been seen of it to show that it

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* Colossochælis. † Glyptodon. ‡ Mylodon.

belongs to the Carboniferous type; thus, though the Lycopods are scantily represented, we still find amongst them Lepidodendra and Sigillaria, but these are now a doomed and expiring race. On making another advance and passing into the Triassic period, their places are vacant, or are occupied by other and wholly different plants; the Keuper is equally barren of Lycopodiaceous forms. When we reach rocks of the age of the Oolites, we discover that the order is represented by but one dwarfed form * found in the Oolites of the Yorkshire coast, and which would be inconspicuous even amongst the Selaginellæ, which are its living representatives. A doubtful Lycopod,† discovered in a Pliocene deposit, constitutes the only representative of the order found in strata of later date than the Oolites. In whatever way the Lycopodiaceous order, whose history I have thus briefly traced, may have originated, we see that its members culminated at an early age of the world, in the extent of their diffusion, in their numbers, in the magnitude to which they attained, in the complexity of their internal organisation, and in the variety of modifications of the primary type which they displayed. At the same time, throughout all these varied modifications, they retained their true Lycopodiaceous features. This persistence of the type is especially seen in the retention of those organs of fructification which are most characteristic of the group. These spore-bearing organs are abundant in the coal measures, where they closely resemble, in all but size, the homologous structures of living species. It is

* Lycopodites falcatus. † Isoetites Braunii.

scarcely necessary to add that the dwarfed aspect, which seems to have characterised the Oolitic species, continues equally characteristic of the plants which represent the order at the present day.

So much new light having recently been thrown upon the structure of the Carboniferous Lepidodendroid plants, it becomes important to know how these discoveries bear upon a limited application of the doctrine of evolution. We have seen that in its genetic transitions from the state of a primary twig to that of a permanent stem, a Lepidodendroid axis undergoes great changes. In the primary state there is a solid central vascular bundle surrounded by a bark; but a cellular axis soon appears within this bundle, which, as it grows, pushes the vessels outwards, where they finally form a vascular cylinder surrounding a large cellular pith. The degree of this centrifugal re-arrangement varies in different plants. It is often difficult to determine how much of this variation is due to age and how much to specific differences; but both in the vascular axis and in the investing bark, so many indefinite modifications present themselves as to make a limited adaptation of the evolutionary hypothesis almost inevitable; at all events the known facts are in no respect opposed to such an adaptation. It is also necessary to state further that the coal measures reveal some other remarkable stems, the exact relations of which are not yet fully ascertained, but some of which may eventually prove of importance in relation to this question.*

* This is especially in reference to the Lyginodendra, Noëggerathiæ, and to the curious Pothocites Grantoni, which latter is sup-

Retracing our steps, we may now follow the fortunes of the Cryptogamic group of the Equisetaceæ. In Palæozoic ages this group appears to have been solely represented by the Calamites—all the plants which some authors separate into the two genera, Calamites and Calamodendra, being included in this term. Dr. Dawson has shown that these plants constituted an important part of the Devonian vegetation; since, even at that early date, they had evidently attained to the half-arborescent condition which they displayed in yet grander fashion during the Carboniferous age. Distinct as these plants are in many of their features, it becomes increasingly evident that they represent the modern Equisetaceæ, though they differ widely from that order in points of detail. At the period referred to, the Calamites were noble plants, shooting upwards from a rich undergrowth of ferns, and mingling their tall and slender stems with those of the Lepidodendroid trees. A central pith became more or less fistular at a very early age, leaving a large cavity, often six inches and sometimes more than two feet in diameter, occupying the centre of each internode or joint of the entire stem. This pith was surrounded by a single ring of longitudinally-disposed canals, resembling those of living Equiseta, each one of which became the starting-point for a wedge-shaped

posed by some botanists to be a Monocotyledonous Angiosperm. This, however, appears doubtful. The genus Antholites, from the coal measures, was regarded as a Dicotyledonous Angiosperm allied to Orobanche; but this idea is now abandoned, and the plant is referred to the group of Gymnospermous exogens, a much more probable determination. I expect that further research will lead to some similar change in reference to Pothocites.

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ass of radiating laminæ of vascular tissue, with regular edullary rays between the laminæ. Each wedge ecame thicker as it grew outwards in consequence of peripheral additions to its laminæ, until the plant finally possessed a woody axis developed in so remarkable a degree as to cause M. Adolphe Brongniart to regard the stems so constructed as belonging to the Gymnospermous exogens, rather than to the Cryptogamic Equiseta. But this is certainly a mistake.

From whatever point of view we study the Calamites, our attention is arrested by the high degree of their developement as compared with that of the living Equiseta. We thus discover that the Equisetaceous type of vegetation first meets our eye in its noblest form, whether we regard the magnitude of the individuals or the high degree of organisation to which they attained. These plants continued to exist, though scarcely to flourish, during the Permian period. The same causes which led to the decline of the arborescent Lycopods were, apparently, equally unfavourable to the Calamites,—though both these types appear to have lingered together in the Permian forests of Russia, and one or two doubtful Calamites even prolonged their fading life into the Triassic period. But though the Calamites waned, a new modification of the Equisetaceæ took their places. In the Triassic rocks of the Vosges Mountains we find Calamites associated with the newer genus, Equisetites; this latter genus approaches much nearer than the former one does to the modern Equisetum, since each node of its jointed stem is furnished with the leafy sheath which is so characteristic of the living genus, and which the Calamites did not possess.

The Triassic age thus becomes an important one in the history of the Equisetaceæ. But whence came this new Triassic form? Did the verticillate leaves of the Calamites now coalesce to form the sheath of the Equisetites, and thus establish a transition from the one genus to the other? Impressed with the importance of the question I visited Strassburg, and enjoyed the privilege of examining Professor Schimper's fine collection of these objects, but I could find no indication of a transition from Calamites to Equisetum amongst these Triassic fossils. The line of demarcation between those which possessed the characteristic sheaths and those which did not was sharp and clear,—a line which separates with equal definiteness the fruits of the two plants; hence I was obliged to conclude that Equisetites afforded no indication that it had been evolved out of a Calamites.

On reaching the Liassic base of the Oolitic rocks, we lose sight of the Calamites. They disappear together with their associates, the Lepidodendræ and Sigillariæ. It is true Sir Charles Bunbury * has assigned the name of Calamites Beanii to a stem which I discovered in the Oolites of Eastern Yorkshire nearly forty years ago, but which I am satisfied is not in any sense an Equisetaceous plant; two other equally doubtful plants from the German Oolites have been similarly named. The place of the Palæozoic genus is now taken by true Equiseta, which are not uncommon in the Oolites of Yorkshire and Brora; but how dwarfed since the days when they reared their aspiring heads in the Carboni-

* *Quart. Journal Geol. Soc. London*, March 1851.

ferous forests! The E. columnare, from the Yorkshire coast, the largest of the Oolitic series, has been at most but a few feet high; whilst E. laterale,* from the yet newer Gristhorpe beds, was a still smaller variety. Other dwarfed Equiseta appear in the Wealden division of the Oolites, and likewise in several portions of the Tertiary series; but their history is everywhere the same: it is the record of a degenerating race. Whether we regard the dimensions to which, as we have seen, they once attained, or the complexness of their more ancient organisation, we must conclude that the Equisetaceæ never occupied a lower position in the vegetable scale than they do at the present time.

There exists an important group of Palæozoic plants—the Asterophyllites and Sphenophyllas—which have long been regarded as the branches and foliage of the ancient Calamites. It is now clear that this opinion is an erroneous one, and that their affinities are more probably with the Lycopods; but since this last point is yet *sub judice*, they must for the present be treated as an independent order. Their external forms, combined with the remarkable peculiarities of their internal exogenous structure, peculiarities isolating them from all the plants which were coeval with them, render them of some importance to our present enquiry. As

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* Sir C. Bunbury notices a specimen of this plant in the collection of the late Mr. Bean, with distinct verticils of leaves instead of nodal sheaths. He places it in the genus Asterophyllites. I cannot accept this determination. Zigno calls the plant a Calamites, which is equally a mistake. The plant is unquestionably a most interesting one.

is the case with the types already considered, geology affords no clue to their origin. We first find them flourishing in the Devonian age; they existed in great numbers, and attained to arborescent dimensions during the Carboniferous period; but they soon declined in importance, being only represented by a single species found in the Permian rocks. We have no evidence of their continued duration after the Permian age, neither have we any plants of more recent date, which present the least claim to be regarded as their lineal descendants. They offer themselves to our notice at the outset in a very distinctive form; they retain their special peculiarities to the end of their career, and they finally succumb to those altered external conditions, which appear to have been so fatal to many of the Palæozoic types of organisation.

The plants which I have hitherto noticed are such as either degenerated gradually, as years rolled on, or finally became extinguished. But I have now to examine the career of a type whose history has been widely different. Of all the plants known to us in a fossil state the ferns are the most widely diffused, and retain unchanged their typical features in the most enduring manner. We find them in the Devonian strata of British America constituting a pre-Carboniferous flora of wondrous richness. Not only are their individual numbers considerable, but we already meet with the conspicuous types with which we are familiar under the generic names of Pecopteris, Neuropteris, and Sphenopteris, and which continued prominent to the close of the Oolitic age. Still more interesting is

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the fact chronicled by Dr. Dawson, that the noble tree-ferns, which have ever constituted the most striking of the many modifications which the fern-type has presented, were not wanting at the early period represented by the Devonian beds. When we leave the Devonians, and ascend to the rocks of Carboniferous age, we meet with similar phenomena; but the latter rocks teach us something additional. I have already called attention to the fact, more largely dwelt upon in recent volumes of the *Philosophical Transactions*, that the Calamites, Asterophyllites, and most of, if not all, the Lycopodiaceous plants of the Carboniferous age underwent changes in their organisation, as they grew in magnitude, equivalent to those occurring in the stems of living Dicotyledonous exogens. Successive additions were made to the exterior of the woody wedges constituting the vascular axis of each of these plants, preparing the stems for assuming the arborescent form to which they ultimately attained; but these growths did not appear in consequence of the trees having become of large size and needed support. To employ a term not strictly applicable to organisms unendowed with a nervous system, it was not a *felt* want followed by a supply. These successive growths began to appear when the plants were of small size and herbaceous habit, and when consequently they no more needed such additional supports than do thousands of still larger plants by which they are not possessed at the present day. The plants in question were destined to attain to arborescent forms, and the supports necessary for such a state began to be prepared for them long before the magnitude of the trees made such buttresses necessary.

The tendency to develope those remarkable growths was evidently inherent in the several types, though it no longer exists in their living representatives. But I have not found any single stem amongst the coal measures which was indisputably that of a fern, in which such exogenous additions had been made to the primary axes. Even when the magnificent clusters of huge fronds hung gracefully from the summits of stems much larger than those of many of the Lycopods and Calamites in which exogenous growths were present, nothing like these growths can be found. These stems of tree-ferns have long been met with in considerable numbers at Autun, in France, where they occur in siliceous nodules belonging to the close of the Carboniferous period, and similar ones have occurred at other places. The internal structure of many of these stems was illustrated by Corda, and they reveal, without a single exception, the same absence of exogenous additions to their vascular axes as that to which I have referred in the case of the British examples. Their vascular bundles are invariably what botanists term closed ones. It appears to me that geologists and botanists have equally failed to recognise all that is involved in this important fact. Physiologically, it demonstrates that something more than mere magnitude underlies the exogenous developement of the Equisetiform and Lepidodendroid plants, because, while it is present in the smallest of the Carboniferous representatives of the latter groups, it is absent, not only from the Carboniferous tree-fern, but also from the tree-ferns living at the present day. It is a notable fact that, while all the other Carboniferous Cryptogamic plants have dwindled down into mere

herbaceous forms, the tree-ferns have retained both their pristine grandeur and their pristine organisation. We have no reason to suppose that the Caulopteris and the Psaronius of the coal measures were grander trees than the Dicksonias and Cyatheas of the present day. Thus, in every important feature, the ferns present one of the most remarkable examples of persistency of a vegetable type which the Palæozoic rocks supply.

It is not necessary to dwell in detail upon the later history of fossil ferns. They continue to appear in various representative forms in the Permian deposits of the Vosges, and they occur in rich abundance in various localities which illustrate the flora of the Oolitic age. Though we are imperfectly acquainted with the vegetable life of the Cretaceous period, we find ferns, including the arborescent Protopteris, the Cretaceous representative of the tree-ferns, in the Cretaceous strata of Bohemia and Silesia. They appear in detached localities in the various Tertiary strata, and, it is needless to add, they flourish in all their primeval glory at the present time.

We must return once more to the pre-Carboniferous strata, in order that we may follow another instructive line of descent, viz., that of the Conifera. This group is of the greatest importance to us, and requires to be examined with some care, because it is far from impossible that the facts of its early history may ultimately be proved to favour the evolutionary theory. My reasons for admitting this possibility are the following ones: many Palæozoic plants have long been grouped together under the common name of Conifers; some

of these I have recently* shown to have no claim whatever to the name, though their ligneous axes have been described by more than one experienced botanist as examples of Coniferous wood,—a mistake most easily made by observers who are not familiar with other portions of their several stems. But when all these obviously non-Coniferous forms are eliminated, there still remains a group known as Dadoxylons, the pith, wood, and bark of which genus appears equally undistinguishable from the same organs amongst living conifers. Judging by these structures alone we should not hesitate to affirm the Coniferous character of the entire group. But unfortunately no trace of a cone has yet been found in the beds in which these Dadoxylons are common. We find them equally in the Palæozoic strata of Europe and of America; but we everywhere obtain the same negative testimony. Calamites, Lepidodendra, and Asterophyllites have bequeathed to us, in greater or less degrees of abundance, their delicate organs of fructification. Remembering how abundantly the cones of living pines strew the ground in every modern pine forest, and also how eminently their woody structure fits them for permanent preservation, we may think it strange that not a solitary example of an unmistakeable cone should have been met with either in the Eastern or Western hemisphere in Carboniferous or pre-Carboniferous rocks. Should it be proved after all that these Dadoxylons bore Cryptogamic organs of fructification, the fact would almost settle the entire

* *Philos. Transactions of the Royal Society*, 1873; see also *Monthly Microscopical Journal*, August 1869.

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uestion of evolution; but I cannot as yet determine whether these trees were Cryptogamic or Phanerogamic, hough all the indications furnished by their stems ncline me to the latter conclusion; neither can I explain the remarkable absence of cones, assuming the trees to have been Coniferous, otherwise than by supposing that they may have possessed a pulpy fruit resembling that of Juniperus or Taxus.* The possibility that the Dadoxylons may not have possessed stamens and carpels derives additional significance from the close physiological affinities which are admitted to exist between the living Conifers and some Cryptogams, *e.g.*, the Selaginellæ, just as, on the other hand, the stems of the Gnetaceæ connect the Conifers with the true Dicotyledonous plants. I know of no physiological problem connected with palæo-phytology which surpasses in importance that of the fructification of the Dadoxylons, hence the discovery of their reproductive organs should be vigorously aimed at by every collector, as a desideratum of the utmost consequence.

On the other side of the question is the fact that the stems of Dadoxylon have a structure identical, in all essential points, with that of stems found somewhat higher up in the stratified series, which latter stems are associated with true cones. The similarity of organisation is so striking that their possession of some common type of inflorescence appears to me

* Dr. Hooker long since arrived at the conclusion that the fruit called Trigonocarpons was that of one of the Taxineous Conifers, in which the fruits are solitary, and not enclosed in cones. It is not improbable that Dadoxylon may have been the plant to which this fruit belonged. Dr. Dawson believes them to belong to Sigillaria.

probable. Every portion of their respective tissues, as well as this combined arrangement, seems to justify our uniting them in a common group. Whatever may be the ultimate decision of science on this point, no doubt exists respecting another fact of equal importance. Even those who have most determinately opposed my hypothesis of exogenous growth as applied to the undoubtedly Cryptogamic flora of the Palæozoic strata, have never doubted that the Dadoxylons possessed an exogenous stem, the growth of which had been accomplished in the same way as that of our modern pines. This is a most important fact, because it involves the admission that, in what are virtually the oldest of our plant-bearing strata we find this pine-like type of stem not only as abundant as it now is in tropical and semi-tropical regions, but as highly organised as in any of the living Gymnospermous exogens, with the exception perhaps of the small order of the Gnetaceæ.

Leaving out of sight for the present the disputed genus Prototaxites, there is no question whatever that Dr. Dawson has found in the Devonian strata of New Brunswick remarkable examples of the stems of Dadoxylon and of other allied forms. Specimens with which my indefatigable friend has supplied me, and which I have submitted to most careful examinations, have thoroughly satisfied me that such is the case. Ascending to the coal measures, we again meet with them in considerable numbers; but it is a curious fact that we rarely find them in the same beds as those which abound in the usual plants directly associated with a coal seam and its characteristic under-clay.

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They much more frequently occur in the form of drift-wood. I have only met with one solitary fragment in the rich deposits of the lower coal measures existing near Oldham, from which so many of my other treasures have been drawn. The specimens have nearly all been derived from the Ganister bed, in which they are associated with an abundance of Goniatites and other marine organisms. This fact seems to indicate that they grew apart from the Lycopods and Calamites, possibly on higher and drier ground, from which they were brought down to the lower levels by streams of fresh water.

In the Permian strata the Dadoxylons, characterised by their peculiar piths, were replaced by the Walchias—plants which approached very near to the living Araucarias. Another step leads us across the boundary between the Palæozoic and Mesozoic strata, when we encounter new Coniferous types in the Voltzias and Haidingeras of the Triassic strata of the Vosges, of which we not only have the branches, but the cones; so that now, at least, we are unquestionably amongst true Conifers. Wood undistinguished from that of Coniferous stems is abundant in the Oolites, whilst the Permian genus Walchia is now found with its strobili attached to the branches. Other cones also existing in various cabinets establish the Coniferous character of part of the Oolitic vegetation. Similar plants are generally diffused throughout the Cretaceous rocks, often occurring in the form of drift-wood. Many of the Cretaceous species approach very closely to living forms; thus Mr. Carruthers has shown* that species of Sequoia (the Wellingtonia

* *Geol. Mag.*, December 1871.

of florists) and Pinus grew side by side during the Cretaceous age, as they now do on the western slopes of the Rocky Mountains. Similar remarks are even still more applicable to the numerous Tertiary deposits which absolutely link the Coniferous vegetation of the past with that of the present time.

The consideration of the Conifers brings us to the closely allied group of the Cycads, which are also cone-bearing plants, though not true *Coniferæ*. The origin of this important group is enveloped in the profoundest mystery. The Carboniferous rocks contain the two genera Flabellaria and Noeggerathea, both of which Brongniart has referred to the Cycadean family, though expressing strong doubts, which appear to be eminently justified, especially in the case of the former of these two genera. It is only when we reach the Triassic rocks of the Vosges that we meet with two unquestionable representatives* of the Cycadean family. In the Oolitic age, as is well known, these plants become the dominant form of vegetation. Some of the Oolitic species possessed organs of fructification closely approaching those of living types; but the genus Williamsonia, though possessing a stem and foliage of the truest Cycadean aspect, bore fruiting organs altogether dissimilar from that of any living form. The Cretaceous age was rich in Cycadeæ, though less so than that which preceded it. It is curious that no Cycads have yet, so far as I am aware, been discovered in strata belonging to the Tertiary epoch; but they now form a narrow interrupted belt, encircling the globe in the

* Zamites Vogesiacus and Ctenis Hogardi.

southern hemisphere, where they are associated with the tree-ferns and caoutchouc-producing Fucoids at the outer boundary of the tropical zone. We thus learn that the Cycads apparently sprang into existence during the Triassic period, and that they have probably continued an uninterrupted life from that age to the present one. Their apparent absence from the Tertiary rocks is probably due to the fact that they had retreated at the close of the Cretaceous age to something like their present narrow range in the southern hemisphere, the northern half of the globe being then, as now, devoid of them.

There still remains for examination the distribution in time of the flowering Dicotyledonous and Monocotyledonous plants; but here the difficulties which we have already met with, due to the imperfections of the record, seriously increase. I have already referred to the very doubtful nature of all the supposed indications of the existence of such plants in the Palæozoic and Mesozoic ages; but there is no doubt whatever that they were in being during the earliest portions of the Cretaceous period, and that their numbers steadily increased during the Tertiary age. Monocotyledons and Dicotyledons are alike met with in Cretaceous strata, the latter being more abundant than the former. The numbers of the two combined classes equal, in the Cretaceous deposits, those of each of the two families of Cycads and Conifers found in the same strata, as Brongniart has already pointed out. On the one hand, we now find palms; on the other, we have representatives of the walnut and the maple, the willow and the hornbeam, the alder and the Comptonia or sweet-

fern,—a remarkably diversified series of types to constitute the advanced guard of a new vegetable race. As we ascend from this Cretaceous platform through the Tertiary deposits, these flowering plants increase rapidly in numbers both of orders, of genera, and of individual specimens. Thus in the Eocene age we find that aquatic Monocotyledons, such as pond-weeds and grass-wracks, have been added to the palms, whilst the latter have also increased in number.

Amongst the Dicotyledons we have now, in addition to the type found in the Cretaceous beds, elms and leguminous plants, gourds and mallows, along with other forms of Phanerogamic vegetation. In the Miocene age still further advances were made. The list now becomes of great length, and comprises plants belonging to at least twenty-five natural orders, and these chiefly consisting of the more generally known living types. Yet greater accessions were made to the flowering vegetation of the Pleiocene period, in which such genera as Myrtus and Tyrus, Cratægus and Cotoneaster, Rosa and Spiræa, Prunus and Amygdalus afford unmistakable evidence that we are approaching the confines of the modern dispensation. We have much reason for believing that, at the close of the true Tertiary epoch, the earth exhibited a Phanerogamous vegetation as extensive as that now living upon its surface.

To furnish such a recapitulation of the successive phases of terrestrial plant-life as is given in the preceding pages is a sufficiently easy task; our real difficulties begin when we try to discover some ex-

planation capable of accounting equally for what existed and for what was lacking in each of those successive phases. Two easy methods of solving these difficulties have been offered to us. We have,—1. The unlimited appeal to creative power, and to an innumerable succession of direct creative interferences, acting in some mysterious way, independently of the action of known or knowable natural forces. 2nd. The supposition that in the earliest of the Palæozoic ages the earth had a flora almost as varied as the present one, but that only detached fragments of it have come down to us. This second hypothesis requires for its sustentation the admission of Mr. Spencer's doctrine of migrations. If we do not find the Cycads in the Carboniferous beds, we must according to that doctrine conclude, not that they did not exist in that age, but that they did not exist in the particular localities in which the known Carboniferous deposits were accumulating; and when they do occur in the Oolitic beds, which now overlie these Palæozoic rocks, and occupy the same geographical areas, it is because the Cycads migrated to that same geographical area from other lands, at a later period of the world's history. To accept the first of these hypotheses without very material limitations is absolutely impossible at the present day; and it appears to me equally impossible to accept the second. I will not be so rash as to predict what novelties future researches may bring to light respecting the Palæozoic fauna, but I cannot doubt that had phanerogamous plants existed during those ancient periods, we should have found some traces of them in some of the many portions of the

globe in which those strata have been examined. we reject *all* special creative interferences actin some hitherto inexplicable way, we must come tc conclusion that some, at least, of the Palæozoic Cr gams and supposed Conifers have undergone succe developements by evolution, and have thus origin the more varied forms of vegetable life with whicl are now acquainted. But so far as this latter h thesis is employed to explain an ascent from le more highly organised forms, the history of all known fossils of these classes is directly opposed tc acceptance of it. I have already shown that, so f the Lycopods and the Equisetaceæ were concer their life-history was the reverse of one of pro sion. They come before us, in the first inst in the grandest of the varied forms which assumed during successive ages. Instead of biting any tendency to develope into yet hi types, the changes which these two classes undergone have all been in the opposite direc While their characteristic reproductive organs hav mained almost absolutely stationary, indicating eq stationary features in their embryonic developen the vegetative organs of both these classes be less and less complex as ages rolled on. stems of both Lycopods and Calamites became highly organised as the noble forest-trees degene into dwarfed and creeping herbs. The leaves ol Calamites became so insignificant as scarcely tc recognisable in the abortive sheaths clothing the s of the Equiseta. To these declining races we apply the words,—

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> "Sic omnia fatis
> In pejus ruere ac retro sublapsa referri."

Let us note at this point how large a portion of the world's duration had elapsed at the time that these cryptogamic forms constituted its chief vegetation. We have no means of estimating that duration save by measuring the thickness of the strata which accumulated during its vast interval. Of course our measurements of that thickness can only be approximate. But our proportions will probably not be very erroneous if we affirm that we have 120,000 feet of deposits below the line separating the Permian from the Triassic rocks, and 11,000 above that line. But assuming that the theory of successive evolutions from a primary germ explains all the phenomena of organic life, how is it that so little progress was made in the upward developement and multiplication of types during what we may fairly regard as representing at least eleven-twelfths of the world's duration, as compared with what took place in the remaining twelfth? Uniformitarianism appears to me to fail utterly to explain the vast difference between the few cosmopolitan types of the Palæozoic and Mesozoic periods and the innumerable ones of the later Tertiary and recent ages. I can understand the possibility of the variations produced by evolution increasing more rapidly in the later ages than in the earlier ones. When the number of primary types was small, the chances of any important variations occurring would be equally so; but every such variety which, through natural selection, succeeded in attaining to specific rank, would become an additional centre whence yet newer variations might spring: and thus, unless neu-

tralised by an equally rapid extinction of older forms, the gain would be almost geometric in its ratio. But we have no indications that such an explanation suffices in the present case to account for the remarkably rapid expansion of the Monocotyledonous and Dicotyledonous vegetation of the later Tertiary ages. The plea of non-discovery does not meet the case, because we are as familiar with the history of the Oolitic rocks as we are with that of the Tertiaries; still less can we fall back upon non-preservation; for there is no cause whatever why the Oolite deposits should not have entombed and preserved an average representation of the vegetation of their own age as readily as the Tertiary deposits have done. The difference appears to me too striking to be accounted for otherwise than by recognising an unusually rapid multiplication of the forms in the Tertiary age, however such a multiplication may have been brought about.*

The history of the ancient Conifers differs from that of the Cryptogams. So far as their stems are concerned, they present as high an organisation as is possessed by any of the modern Pines or Araucarias. The Devonian species exhibit a somewhat more complex structure of wood-cell than some of the Carboniferous species. As we trace these plants through successive epochs, especially from the points in time at which we know

* The wide-spread diffusion of true Phanerogams in the Tertiary strata, from Greenland to the Himalayas, is too remarkable to be accounted for by directions of migration, or by any other merely accidental conditions of distribution or discovery. *mutatis mutandis*, the argument applies, in like manner, to the equally wide diffusion of the more limited series of types which characterise the flora of the Palæozoic age.

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true cones to have been in existence, we discover a remarkable persistency in all their essential features. Without displaying any advance in organisation, their magnitude has probably culminated in the Californian Sequoias. The ferns present us with yet more marked examples of persistency of type: they have neither advanced nor receded. What they now are they were, essentially, when the Devonian forests of New Brunswick were submerged beneath a semi-tropical ocean. As I have already pointed out, they existed during that early age in their grandest condition as tree-ferns, and the same graceful forms still adorn the semi-tropical forests of South America and New Zealand.

It is clear that we have no means of tracing any of these varied types of Equisetaceæ, Ferns, Lycopods, and Conifers to any common stock. Hypothesis may assume that they had such an origin in some epoch antecedent to the Silurian age, but no shadow of proof exists that such was the case. But it does not follow from this that evolution played no part in their economy. On the other hand, I think we have strong reasons for inferring the contrary. The longer I study the species of any one of these groups, and the larger the number of specimens, especially if obtained from different localities, which I examine, the less am I able to obtain satisfactory specific definitions. That more or less permanent variations may result from the two processes of evolution and natural selection in the present age, I presume no one familiar with scientific botany now ventures to doubt; and, so far as I can see, the ancient flora justifies our arriving at the same conclusions

from very similar data. The great question to be answered is this,—How far do these variations extend? are they boundless, or are they confined within definite limits? The facts of palæophytology appear to me to favour the latter rather than the former conclusion. We have not much difficulty in distinguishing the great Palæozoic types from one another. When we endeavour to demarcate genera our difficulties increase, and as to the majority of existing definitions of specific differences, I utterly distrust them. At all events, after labouring amongst these objects for nearly forty years I know less about those distinctions than I thought I did during the first six months of that long period of study. I can only account for this difficulty by supposing that extreme varieties are inextricably linked together by intermediate forms, produced through the action of the varying external forces which lead to evolution.

Whatever may be the difficulties which we encounter when grappling with the primeval flora, still greater await us as we ascend from the older to the newer strata. The introduction of the Cycads, during the Mesozoic age, constitutes one of the first and most marked of these difficulties. Whence did they come? I can discover no plant which seems to be transitional between the Palæozoic plants and the Oolitic Cycads. Had the curious South African Stangeria, with its fern-like leaves associated with a truly Cycadean stem and fruit, been met with in the Permian and Triassic rocks it might have been quoted as an excellent example of a link between the ferns and the Cycads; unfortunately, this apparently generalised type appears a

the end of the story, where it is not wanted for such a purpose, instead of at the beginning, where something like it is required; but we discover no Stanteriæ in these transitional deposits, nor any other plants capable of being construed into stepping-stones, conducting us from the Carboniferous types to the Oolitic Cycads.

The above argument, thus applied to the origin of the Cycads, is equally applicable to the introduction of the several types of Angiospermous Phanerogams of the later geological ages. We see nothing in the well-marked ferns, Cycads, and Conifers of the Wealden beds, likely to be developed into the gales, alders, willows, and maples, of the lowest Cretaceous deposits of Scania; neither do the latter plants show any greater indications of transition into the still more numerous forms of the later Tertiaries than do the corresponding living forms at the present time. The generic types of these various forms are so distinct that Professor Heer has been able to identify one after another of them, with an almost instinctive accuracy, and the discovery of various fruits * has confirmed, in many cases, the conclusions at which he had arrived from the study of the leaves alone. If, then, these generic types first come before us in such clearly defined forms, when and where did the transitional states make their appearance? The extreme evolutionists constantly affirm of those who believe in special creations that they "habitually suppose the origination to occur in some region remote from human observation,"

* *E.g.*, the Magnoliæ of Greenland.

and that "the conception survives only in connexion with imagined places where the order of organic phenomena is unknown." It is legitimate to retort upon them that they as habitually resort to "strata now covered by the sea"—to rocks "from which all traces of such fossils as they probably included have been obliterated by igneous action," and to mysterious "migrations from pre-existing continents to continents that were step by step emerging from the ocean." Unfortunately, so far as the vegetable kingdom is concerned, we have, as yet, failed to discover any traces of these mysterious strata or hypothetical continents, in which the transitions from one plant-type to another were being brought about. The believers in special creations are not the only reasoners who have made free use of hypothetical possibilities.*

I have already called attention to the wonderful rapidity with which new vegetable types seem to have

* The facts now known appear to indicate that the vegetable types have been much more persistent throughout all geological time than the animal ones; especially more so than the vertebrate forms. The wonderful inosculating Vertebrata which have been discovered within the last quarter of a century, have no parallels amongst the vegetable types. In the former group, generalised structures frequently occur for which it is impossible to find a place in any of the existing divisions of the Vertebrata, because they have something in common with several of those divisions. I do not believe that these differences are really created by our being more perfectly familiar with the animal than with the vegetable kingdom, especially in the oldest and the newest ends of the great chain of vegetable life. We are much better acquainted with the flora of the later Carboniferous age than with its fauna; but our knowledge of the Tertiary flora—thanks to the valuable labours of Professor Heer—is following closely upon that of its vertebrate life. The known plants which we are unable to place in their respective typical groups are comparatively few in number. With the animals it is far otherwise.

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ng into existence during the comparatively brief
od represented by the Cretaceous and Tertiary
ta, compared with what occurred during the vaster
æozoic periods. It is important to notice that the
ner is also the age during which the mammalian
na was undergoing a similarly rapid developement
und becoming closely approximated to that now
elling upon the earth. We thus see that the Tertiary
e, especially, was characterised by a developement of
w animal and vegetable types, altogether dispropor-
nate to its actual duration. It is difficult, in the face
this fact, to accept, unconditionally, the doctrines of
e uniformitarians, since those facts seem to declare
at the organising forces have not acted with uniform
tensity. By the help of artificial selection, man has
rought into existence many new varieties of pre-exist-
g plants and animals, most, if not all, of which, were
is protecting hand withdrawn, would soon revert to
eir primal forms. We have no evidence that unaided
ature has produced a single new *type* during the
istoric period. We can only conclude that the won-
lerful outburst of genetic activity which characterised
he Tertiary age was due to some unknown factor,
which then operated with an energy to which the earth
ras a stranger, both previously and subsequently. The
nowledge of this factor is what we need in order to
erfect our philosophy; and, until we obtain that know-
edge, many things must remain unaccounted for, so far
s primeval vegetation is concerned. Even Mr. Wallace,
rdent evolutionist as he is, has been driven by the
tudy of the cranium of the savage to a somewhat
imilar conclusion. When this unknown x is found,

and when the force thus symbolised is united with the forces producing the indisputable phenomena of evolution and natural selection, we may hope to see our way through the genetic mysteries which now perplex us.

For my part, I cannot doubt the existence of a clearly defined boundary-line which separates the knowable from the unknowable, and beyond which there exists an unfathomable region of truth, which man cannot penetrate, but into which thoughtful men will strive to enter to the end of time. Scientific investigators may be compared to a group of travellers starting from a common centre, and following radiating lines divergent from that point of departure. Some will succeed in wandering further than others; some, whose intellectual powers are limited, may think that they have reached the boundary-line when they have in truth merely reached the limit of their own capacities. Others will penetrate deeper into Nature's mysteries, even, it may be, in relation to the origin of things, than their predecessors have done. But sooner or later every explorer will be brought face to face with a dark veil, intangible and invisible, but impenetrable. Man here seems to reach the point where the finite and the infinite meet. Looking back he may meditate upon the organic and inorganic entities with which his long journey has familiarised him, and upon the wondrous properties which they possess. He stands face to face with the mysterious phenomena of matter and force, for the existence of which he can discover no natural cause; and when, striving to penetrate the gloom, he asks whence these things came, why they are here, and

w they became so wondrously endowed, the silent rkness gives him no response; but Nature's very ence, so impressive, so suggestive of reverential awe, eems to become vocal, and to say to him in solemn nes, "Put off the shoes from off thy feet, for the place hereon thou standest is holy ground."

W. C. WILLIAMSON.

VIII.

Science and Medicine.

Medicine is an art which has long striven, and which is now striving more vigorously and more successfully than ever, to reach the position which will entitle it to a place among the sciences.

It is conceivable that the time may come when the exact nature of those alterations in the healthy processes of our bodies, which constitute disease, will be so accurately known, that their prevention would be easy, if only the wisdom and virtue of men were great enough to tolerate the control which the higher knowledge will suggest. It is conceivable, too, that the objective phenomena of disease will be so clearly traced to, and connected with, the changes in structure which accompany them, that the physician, in employing drugs and other remedial agents, will never rely only upon the experience of those who have preceded him, but will invariably be guided by an exact knowledge of the modes in which he can influence the different structures of the body. Not only will the physician be able to predict the occurrence of disease, to detect and differentiate it more accurately than at present, and to treat it more efficiently, but, in virtue of this knowledge, he will be enabled, under given circumstances, to fore-

tell, with almost unerring accuracy, the result. Then, indeed, medicine will be entitled to the position of a science.

To those who are acquainted with the successive stages through which medicine has passed, and who know the modes of thought and the methods of investigation which are followed by her most active promoters, it will not appear that we are indulging in vain hopes or idle speculations when we assert that the time is not far distant when she may legitimately rank as a science. Many, indeed, will believe that we are doing her but scanty justice in questioning her present claims to such a place. It will, however, only be when general laws connecting disease with health and establishing a perfectly rational system of therapeutics shall be applicable to the whole body of medical facts, that the term science will be legitimately applicable to medicine. Experimental pathology, studying the synthesis of disease, and experimental pharmacology, localising the action of drugs on the tissues and organs of the body, are fast following in the steps of the rapidly advancing science of physiology, of which they are but departments; and, young though they are, are furnishing the materials for a real science of medicine.

If medicine can as yet be scarcely spoken of as a science, it must be conceded by every one that, from the earliest times, her study has been associated with that of the sciences; and that, while she has invariably profited by the discoveries which have been made in the sciences which constitute the bases of biology, in her turn, she has furnished some of the most ardent and successful contributors to pure science.

In the following pages I shall refer to the circumstances under which the first successful schools of medicine were founded; I shall point out how great an influence the progress of the sciences of anatomy and physiology has exerted on practical medicine; and, after dwelling at some length on an interesting period in English scientific history, when experimental physiology was cultivated amongst us with pre-eminent success, I shall endeavour to show that there is good reason to believe that we may yet emulate our old achievements in the science which, above all others, constitutes the foundation of all rational medicine.

It is since the days of Hippocrates that the study of medicine has been intimately associated with that of science. The Hippocratic books, of which many, as, the *Epidemics*, the *Aphorisms*, and the *Prognostics* were undoubtedly written by the Father of Medicine, prove that, in the fourth century before Christ, there lived in Greece a man, imbued with the scientific spirit, worthy to be considered the first real contributor to scientific medicine. Of a family which claimed to have lineally descended from Æsculapius, and whose members had, from time immemorial, served as priests in the Asclepiea, or temples consecrated to the god of Healing,—learned in the lore which had been transmitted from generation to generation of these priest-physicians, and possessed of a mind imbued with the culture and philosophical taste of the period in which he lived, Hippocrates, the contemporary of Socrates and Plato, founded the first scientific school of medicine. He devoted himself to studying, in as thorough a manner as possible, the natural history of disease,

establishing by comparison with the healthy body, as a standard, the characters by which individual diseases may be recognised, tracing out the circumstances (as, for example, meteorological conditions) which appear to influence their production, and, by numerous observations, determining the influence of different drugs in controlling the phenomena of disease. Hippocrates, indeed, laid the foundation of that rational empiricism, *i.e.*, of that system of rational experimentation, which has been, and still continues to be, of infinite use to practical medicine.

The Æsculapian temple of Cos was one of many erected in Greece, Sicily, and Italy. These temples served as hospitals or dispensaries, whither patients thronged for advice from the neighbouring countries; and as schools of medicine, where those belonging to the caste of the Asclepiadæ were initiated in the secrets of the healing art.

Hippocrates was one of those great men who possess the power of imparting some measure of their own enthusiasm to those whom they instruct, and he, therefore, succeeded in founding a school—in leaving behind him pupils, who continued the work which he had commenced, and who establish a direct link between the temple of Cos and the school of Alexandria—that school which, whilst it added to our stores of medical knowledge, served to preserve and transmit to us some of the old Greek lore which would otherwise have been irretrievably lost. Of the relatives of Hippocrates we know that some—as Thessalus and Draco—were probably the authors of treatises on medicine and surgery, which form a part of the so-called Hippocratic

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Collection; one, Diocles of Carystus, acquired great reputation as a physician, whilst of Praxagoras of Cos we know, from indirect sources, that he was an anatomist of distinction, who studied especially the anatomy and physiology of the circulatory system, anticipating many of the discoveries of Aristotle, whilst he avoided some of the errors into which the great Stagyrite fell. His knowledge of anatomy appears, indeed, to have been so great, that it has led some to infer that he had overcome the scruples which the Greeks entertained concerning the dissection of the human body. If we consider the causes of the celebrity of the Hippocratic school, we shall fairly conclude that that celebrity was due to the scientific path upon which its founder entered, and to the positive scientific discoveries which were made by his successors.

From the school of Cos we are naturally led to the school of Alexandria. While we find in the past history of Europe that, at various times, princes and men of wealth became celebrated as patrons of poets, philosophers, and artists, in no city and in no country have all departments of human knowledge, including medicine, received such impartial support as they did in Alexandria under the Ptolemies. In this city, where Theocritus taught poetry and Euclid geometry, a school of medicine sprang up which became distinguished for the numerous discoveries in anatomy and physiology which emanated from it, and in which surgery underwent remarkable developements. Herophilus and Erasistratus are the two greatest names connected with the Alexandrian school. Not only permitted, but actually encouraged, to dissect the human body, they

made contributions to anatomy and physiology which surpassed all previous ones. The knowledge which they acquired led immediately to the most important results. These two anatomists and physiologists became great surgeons, and the school of which they were the chief ornaments was soon thronged by strangers desirous of acquiring the medical knowledge which could nowhere else be obtained. Within a very short period of time Alexandria became celebrated for the number and excellency of the medical men who practised there, and who were the first to sub-divide, for the sake of expediency, the practice of medicine into certain great departments, which were followed out by different classes of practitioners.

Nothing can be more evident than the connexion between the scientific foundation of the school of Alexandria and its remarkable success as a medical school. Whence, it may be interesting to ask, was derived the scientific element which proved so favourable to the developement of the Alexandrian school? It was undoubtedly derived from that of Cos. Of the three great teachers who founded the Alexandrian school of medicine, and whose names have been transmitted to us, two belonged to the school of Hippocrates, having been educated in the Temple of Cos. Of these one was Cleombrotus, the physician; the other, Herophilus, the anatomist. Herophilus was the pupil of the chief anatomist of the Hippocratic school, viz., Praxagoras, and it appears as natural to connect the discoveries which he made at Alexandria with the teaching which he had received at Cos, as it is to admit, at a subsequent period of medical history, that

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the discoveries of our countryman Harvey were in some measure due to the directing influence of his Paduan master, Fabricius. In truth, the influence which a great teacher, the founder of a great school, exerts on the generations which follow him can scarcely be overestimated.

The two examples which have been cited illustrate the circumstances under which, long ago, the first successful schools of medicine were established: that the success of the schools of Cos and Alexandria was a natural consequence of the scientific basis on which they were founded, scarcely admits of a doubt. If, at Alexandria, in the space of very few years, scientific discoveries were made which greatly eclipsed those of Cos, the reason is to be found in the fact that in the Egyptian city the study of science was encouraged by the supply of those means which were absolutely essential to its prosecution, but which were not afforded in Greece.

Were this a systematic essay on the early history of medicine, I should have to consider the influence exerted on its progress by that great disciple of the Alexandrian school, Galen, to whom we owe so much of our knowledge of Greek medicine, who enriched anatomy and physiology with many important discoveries, but who nevertheless exerted, during many centuries, an influence upon his successors which no one would have regretted more than himself; I should have to point out that on the ruins of the Alexandrian there grew up an Arabian school of medicine, by which little was added to the scientific knowledge which had been previously amassed, but which produced some

good physicians; that in Rome many Greek physicians lived, attained eminence, and left some important works which cannot, however, with justice be said to have greatly influenced the progress of medicine. Among the Romans medicine was essentially an exotic; they borrowed their physicians, as they did their artists, from Greece.

That medicine and the allied sciences should have shared the fate of other studies during the dark ages can occasion no feeling of surprise; but we do wonder when we learn that for a long time after the revival of letters medicine made but little progress. The return to the study of Greek letters tended to the developement of a culture which had long ceased to exist; yet it proved injurious to those who ought, from the nature of their pursuits, to have engaged in original scientific studies, for they indulged in pedantic disputes concerning the, to them, almost oracular writings of Aristotle and Galen, without following in their steps as discoverers of new facts.

The revival of anatomy and surgery preceded by a considerable interval that of physiology, and by a long interval that of medicine proper. This revival commenced early in the fourteenth century, when Mondini, at Bologna, re-introduced the practice of dissecting the human body, and published an illustrated work on anatomy. It only attained, however, its full developement in the sixteenth century, with Vesalius, Servetus, and Fabricius, Eustachius, Fallopius, and Silvius. So great is the value which has ever been attached to science by those who intend to devote themselves to the practice of medicine, that the great Italian anato-

mists of the sixteenth century readily attracted men of all countries to the universities in which they taught. The history of those universities clearly enforces the lesson which we gather from the whole history of medicine, viz., that no medical school has ever risen above mediocrity, or, having attained to a high position, has succeeded in maintaining it, in which the study of the sciences has not been cultivated in a conspicuous manner.

The revival of anatomy did not lead to a revival of the proper method of studying all departments of medicine. Surgery, however, could not escape the influence of the fresh interest with which the study of anatomy was pursued, and for several reasons, of which one that should not be omitted is, that some of the most distinguished of the early Italian anatomists, as Vesalius, Fabricius, and Fallopius, following the examples of the old Alexandrians, Herophilus and Erasistratus, practised surgery as well as taught anatomy. It was in France, however, that surgery underwent its greatest developement, firstly, under Guy de Chauliac, who, it is interesting to know, studied anatomy under Mondini, at Bologna; secondly, under Ambroise Paré, the great Huguenot surgeon, who affords one of the best examples of success due to the combination of intellectual power and moral worth. Ruthlessly attacked by the schoolmen of the old Paris faculty, Paré appealed from books to nature. He never tired of anatomical investigation; his clear and unprejudiced insight dispelled a swarm of fallacies; and his kindly nature instigated him in his opposition to many of the barbarous practices which he found in

favour with the surgeons of his time. He had his reward; for no man has ever more completely silenced wordy opposition by good work, and won the esteem and the love of men of all ranks by the solidity of his mental achievements, and the loveable goodness of his nature.

Although the study of structure and the study of function were probably inseparably connected from their origin, the former study outstripped the latter; and, some time after anatomy had found in Italy a large number of ardent workers, physiology remained very much in the same state in which it had been left by Aristotle, Erasistratus, and Galen. Towards the end of the sixteenth century that spirit of physiological inquiry began to manifest itself which developed so remarkably during the following century, which led William Harvey to win for England the glory of the discovery of the circulation of the blood, and which characterised in a remarkable manner the group of men who were chiefly concerned in founding and rendering so soon illustrious the Royal Society of London.

It has often happened in the history of science that, at a particular period, one country has led the van of progress, while soon after, for reasons which it is difficult to discover, it has been compelled to occupy a secondary position. There are, in truth, great epochs in the scientific history of every country, as there are epochs in the history of every science. It would be erroneous to suppose that the periods of slow developement necessarily indicate commencing decay. A continuously brilliant success is as impossible in the case of any body of men as in the life of any one man, however great.

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We in England are now leaving behind us a period which has been so barren of discoveries in experimental physiology, that some almost forget that this science is one for which the intellect and genius of Englishmen are peculiarly fitted, and to which they have contributed in a pre-eminent manner.

The circumstances which attended the rise of the English school of experimental physiology are so interesting as to warrant a rather more detailed examination of them.

The brilliant first chapter in the history of physiology was written by the master-hand of William Harvey. Completing his education in the University of Padua, under the famous Fabricius ab Aquapendente, Harvey pursued the studies and gathered the knowledge which enabled him, before the first twenty years of the seventeenth century had expired, to announce to the world his discovery of the circulation of the blood. Great though his merit was, Harvey's discovery was one towards which all the work which had been done in the period immediately preceding directly tended. That he was truly a disciple of Fabricius, and that the mind of the master had left no slight impression upon that of the pupil, is proved by the fact that Harvey's studies on the circulation and on reproduction related to subjects which had specially attracted the attention of the great Paduan anatomist and his contemporaries. Inasmuch as Harvey was essentially a pupil of the Italian school, as his discovery was contributed to materially by others who were not Englishmen, and as he lived at a time when no band of physiological workers existed in England, I may pass by the

history of the discovery of the circulation, glorious though it is to us, with the remark that, quite apart from the light which it shed upon physiology, and therefore upon medicine, it served as a stimulus to original research in England, impelling many of all ranks and professions to enquiries capable of yielding such splendid results.

About the middle of the seventeenth century, in various countries of Europe, especially in Italy, men of learning associated themselves and founded societies in which they prosecuted with advantage literary and scientific researches. Among the scientific societies one most worthy of notice was the celebrated Accademia del Cimento, which was founded in Florence, and which, in its short life of ten years, furnished valuable contributions to physical and physiological science. Shortly after the foundation of the Florentine academy the much more famous Royal Society was founded in England—a society whose history is associated in the closest manner with the great mathematical, physical, and physiological researches of the seventeenth century.

It was in 1660, the year of the accession of Charles II., that a number of men interested in scientific study met together in the Gresham College, in London, to "consult and debate concerning experimentall learning." Many of these men had, at previous periods, met in London and at Oxford for similar purposes, but had been compelled by the political disturbances of the times to interrupt their meetings. Possessed of no inconsiderable influence, these men of science—of whom the most enthusiastic and one of the most distin-

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uished was Robert Boyle, seventh son of the Earl of Cork—soon received marks of the Royal favour; for no later than the 15th July, 1662, a charter was granted by Charles II. to the Society which they had founded, constituting it "the Royal Society."

The scientific academies in olden times, as the Royal Society, conducted their proceedings in a very different manner from that which is pursued now. At these meetings not only did the members or Fellows communicate the results of observations which they had made elsewhere, but experiments in physics, chemistry, and physiology were exhibited, either by the Fellows themselves, or by the salaried officers, termed operators or curators, who devoted their time to the preparation of suitable experiments and to the conducting of original investigations. They thus became schools of experimental science, in which the Fellows enjoyed the opportunity of witnessing the performance of experiments by persons well qualified to instruct; and they therefore supplied, to a certain extent, the place of the laboratories which have in recent times been devoted to the teaching of the experimental sciences, and which have contributed powerfully to their advance whenever they have been presided over by men of originality and enthusiasm.

It was in connexion with the Royal Society that nearly all the great discoveries in physiology were made in England during the seventeenth century. Any one who peruses the first volumes of the *Philosophical Transactions* must acknowledge that, for many years after the foundation of the Royal Society, the most interesting and most valuable communications related

to physiological science, to which, as we shall show in the sequel, men of all ranks and professions devoted themselves with enthusiasm. That the founders of the Royal Society intended, from the very first, to direct their attention to biology appears evident from the first charter which they obtained, and which confers upon the Society the right to demand, receive, and dissect, the bodies of executed criminals.

It is in the pages of the *Philosophical Transactions* that we find the full records of the remarkable experiments on the transfusion of blood from the blood vessels of one animal to those of another, which were first performed by Dr. Richard Lower at Oxford, in the year 1664, which were repeated on numerous occasions at the public meetings of the Royal Society, and which, as we know from the writings of contemporary historians, gave rise to great excitement in the metropolis. It is in the pages of the *Philosophical Transactions* that are recorded the magnificent researches of Boyle and Hook, which were to lay the first foundations of a true theory of respiration; and it is to a young Fellow of the Royal Society—Robert Mayow—that we must attribute discoveries in chemistry and physiology, which, while they anticipated many of the researches of Lavoisier, were, in some respects, even more correct than those of the great Frenchman.

The history of respiration appears, indeed, to be a record of British physiological triumphs, the true importance of which cannot be appreciated unless we consider the state of knowledge on the subject at the time when Boyle and Hook devoted their attention to it.

The ancients, and among them Aristotle, had indulged in speculations regarding the relations of air to animals, but had collected no positive information on the subject. Leonardo da Vinci (who lived toward the close of the fifteenth century, and who, by the versatility of his talents—for he was a distinguished artist, a physicist, and a naturalist—reminds us not a little of one of the first presidents of the Royal Society, Sir Christopher Wren) had, it is true, asserted that combustion can only take place where air is present, and that no animal can exist in the atmosphere which is incapable of supporting combustion; but we do not know on what precise grounds these statements were based.

One of the doctrines which had found most favour with the ancients—concerning the influence of the air which is taken into the lungs in respiration—taught that it served to cool the blood; an opinion which, curiously enough, was revived by Descartes and Swammerdam.

In conformity with this hypothesis, the ancients, who were well aware that animals which are confined in a limited space of air perish, attributed death to the injurious properties which heat imparts to the air. Making use of an air-pump which had been constructed for him by Robert Hook, and which was a more perfect instrument than the original air-pump then recently invented by the physicist of Magdeburg, Otto von Guericke, Robert Boyle proved, in the most convincing manner, by an extensive series of experiments, the absolute dependence of animals upon atmospheric air. Subjecting animals belonging to various

divisions of the animal kingdom to the influence of his air-pump, he studied the phenomena of asphyxia, or suffocation, which resulted; he discovered, not only that atmospheric air was essential to animal life, but that animals cannot live in a confined space unless the air within it be renewed. He corrected the error into which the ancients had fallen in reference to the cause of death, by placing animals in spaces containing a limited quantity of air which he cooled artificially; and he was led to surmise that the air contains a substance absolutely necessary to the processes of combustion, respiration, and fermentation.

Aristotle had declared that large animals respire, but that small ones do not, basing the latter statement on the supposed fact that insects do not breathe. Boyle's experiments with the air-pump proved, however, the falsity of the assertion; and his physiological discovery was confirmed by the researches of the distinguished Italian anatomist, Malpighi, who describes the respiratory apparatus of insects in a remarkable work on the silkworm, which he dedicated to the Royal Society in 1669, having been elected a Fellow but one year previously.

Born the very year of Bacon's death, and a contemporary of Galileo, Boyle's aim seems to have been to establish on the basis of physical and physiological experiment, the doctrines of the Inductive Philosophy, which our illustrious countryman had embodied in a system, and of the soundness of which the labours of the great Italian astronomer afforded such abundant proof. Truth-loving, modest, and untiring, as he is represented to have been, Robert Boyle lived and died

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one of the most original, most prolific, and most trustworthy teachers of experimental philosophy whom the world has ever known.

In 1664 Hook demonstrated that the essential phenomenon in respiration is the admission of air to the lungs, and that the movements of the chest in inspiration and expiration were accessory and necessary, though not essential, to the process, thus furnishing facts to be used by the founders of the chemical theory of respiration for overthrowing the mechanical theories which were advocated by many physiologists, and, amongst others, by Hales.

Hook, having made openings in the walls of the chest of living animals, found that not only could he keep up life during considerable periods of time by inflating the lungs with air by means of bellows, and allowing the air to be expelled from the lungs by the natural elasticity of their tissue, but that animals continue to live after their lungs have been perforated, provided that a stream of atmospheric air be kept up through them. Hook thus showed that the movements of the chest and the movements of the lungs are not essential factors in the process of respiration, the mere contact of air with the interior of the lungs being sufficient to maintain life.

Richard Lower, to whom we have already alluded as the originator of the process of transfusion, and who made valuable discoveries relating to the anatomical structure of the heart, now added a most important discovery to those of his colleagues in the Royal Society. He observed, on opening the chest of living animals, that the blood contained in the pulmonary

artery, that is to say, the venous blood expelled from the right side of the heart, was of a dark colour, which changed to florid-red, on its passage through the lungs, providing artificial respiration was kept up, while in the absence of artificial respiration the brown colour remained permanent. Moreover, he proved that when dark or venous blood, drawn from the body, is shaken with air it assumes the florid hue of arterial blood.

Among the contemporaries of the distinguished men whose researches I have just referred to was, as already stated, Dr. John Mayow, a man of the highest genius, whose death at the age of thirty-three, appears to us, who look back upon the works which he left behind him, to have been one of the most terrible losses which science has ever sustained. In his treatises, published at Oxford in 1674, he describes the experiments which led him to conclude that atmospheric air contains a substance which he denominated nitro-aerial spirit, which is consumed when bodies burn as well as when animals breathe. He placed animals under bell-jars containing air, and dipping them in water, he found that the volume of air gradually diminished. He believed that, in the process of respiration, the venous blood circulating in the lungs combined with the nitro-aerial spirit of the respired air, and that the combination was attended with the evolution of heat, which served, in part, to maintain the animal temperature. He believed that, in the process of respiration, gaseous impurities are removed from the blood. Mayow supposed that the rusting of iron in air was due to its combination with nitro-aerial spirit, and he determined that when antimony is burned in air it increases

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in weight in consequence of its having combined with the substance whose existence he had surmised, and which was discovered, a century later, by Priestley, Lavoisier, and Scheele, viz., oxygen. Mayow, in addition, studied with great accuracy the action of the muscles engaged in respiration, and speculated concerning the source of the energy of muscles with a subtilty and accuracy which have surprised some of the most recent investigators.

He asserted that, in order that muscles should be capable of effecting movements, two things were required, viz., the supply by the blood of matter to be burned, and the presence of oxygen (nitro-aerial spirit) obtained in the respiratory process; he considered that the combination of combustible matters with oxygen, continually going on in the muscles generally, and especially in the heart, must be necessarily attended with the evolution of heat.

Whilst these researches were being carried out, Dr. Thomas Willis was adding to our knowledge of the anatomy of the brain, being aided in his researches by Lower, and availing himself of the pencil of Sir Christopher Wren; and, about the same time, another Fellow of the Royal Society, Clopton Havers, was contributing to our knowledge of the structure of bone.

The discoveries to which some reference has been made were all contributed to science during the first years of the existence of the Royal Society; and nearly all became known through the medium of the *Philosophical Transactions*. It is not a little remarkable that so many should have been due to two most active Fellows who, however, were by profession quite uncon-

nected with medicine, but who were led to their enquiries by their zeal for the discovery of the truth, and by the enthusiasm for physiological pursuits which appears to have been a characteristic of their time. Of the men to whom I have made special reference, the youngest, John Mayow, died in 1679; Boyle died in 1691; Richard Lower in the same year, and Robert Hook in 1703. With them fell the pillars of the glorious school of physiology which they had founded. If we now enquire into the causes which led to the success with which its members worked, we shall find that, in all probability, it was due to the enthusiasm for biological investigation which had been lighted up, first by the discovery of the circulation of the blood by Harvey, then by that of the lymphatics, by Aselli of Cremona, and probably also by the extraordinary transfusion experiments made by Dr. Lower and Dr. King. These experiments had, as was previously mentioned, quite surprised scientific men, who reasoned that if the blood of one animal, even the blood of man, could be replaced by that of another, without apparent injury, the operation of transfusion might prove of infinite value to humanity. Might not the diseased be cured by the removal of their blood and the introduction of that of healthy persons into their vessels? Might not the vigour of youth be restored by these means to the old and decrepit? These speculations, of which the falsity was soon proved, tended, no doubt, to enlist the sympathies of people for the study of physiology, and to impress them with its importance; it became the pursuit of others than physicians, and took a place among the sciences to be cultivated by erudite men.

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It must not be supposed that I forget the debts which physiological science owes to men of other countries than our own who lived in the seventeenth century. Did not Aselli discover the lymphatics and Pecquet the thoracic duct? Did not the great Malpighi and the illustrious Loewenhoeck apply the microscope to the investigation of the structure of animals and plants, and thus lay the foundation of the study of microscopic anatomy? In spite of these and many other discoveries which were made abroad, it remains quite true that in the seventeenth century, at the time when physiology made its greatest advances, the British school of physiology occupied an unrivalled position. The discoveries which were made in the second half of the century in reference to the functions of respiration were only second in importance to the great achievement of Harvey; and, as they were the results of the labours of many men, they prove in a satisfactory manner how great is the aptitude which Englishmen possess for physiological research.

But to return from science to medicine. Notwithstanding the impetus which Paré had given to surgery, notwithstanding the discoveries in physiology which the seventeenth century had produced, medicine made but little advance. The old Hippocratic methods of studying with great care the phenomena of division, and establishing, quite regardless of any theories as to their action, the modifying influence of regimen and drugs, remained in abeyance, and the medical mind occupied itself in disputes concerning the essential nature of diseases and founding elaborate systems of pathology which depended upon the utterly erroneous

views which were entertained by their originators. There were not wanting, however, some exceptions, and conspicuous among them was our great countryman, Sydenham.

It is to two universities that the credit may fairly be adjudged of having founded schools which were destined to revolutionise medicine: these were Leyden and Edinburgh. It was in 1709 that Hermann Boerhaave was elected to the chair of medicine in the University of Leyden. Erudite and eloquent, possessed of moral qualities which commanded universal respect, sagacious as an observer of disease, not inclined to commit himself unreasonably to any of the schools into which, at that time, physicians were divided, Boerhaave could not fail to attract pupils. He was truly a great teacher; and although, in accordance with the mode of thought of the time in which he lived, he unfortunately occupied himself too much with mere hypothesis, he left behind him writings which prove how great a physician he was, and pupils who were to effect the most remarkable revolutions in medicine. Of these two stand out prominently. In Albert von Haller, Boerhaave found a disciple destined to found the modern school of experimental physiology; in van Swieten, one who was to become the ornament of the University of Vienna. It is difficult to form a correct estimate of the influence which the erudite and critical spirit of Haller, and his examination of the properties of the living tissues, exerted on medicine; for the methods of observation employed in physiology are essentially the same as are used in medicine, and the mode of thought which is required to form correct

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physiological inductions is that which yields the greatest fruits when applied to medicine.

It was Cullen who established the reputation of the University of Edinburgh as a school of physic. Like all who have contributed greatly to the progress of medicine, Cullen was possessed of the scientific culture of his time. Commencing his career as a professor of chemistry in the University of Glasgow, Cullen became professor of the practice of physic in the University of Edinburgh at a period when science was to undergo a great revolution. Like Boerhaave, Cullen possessed great learning, and like him he was one of the most sagacious of physicians; but he was far more wary than the professor of Leyden in advancing theories to explain imperfectly-ascertained facts. With him was infused into Edinburgh the spirit which gave life to a school of scientific and practical physicians rarely exceeded, certainly not surpassed, in the past or present century, and from which have emanated many of the most illustrious physicians of England.

In an essay treating of the influence which science has exerted on the progress of medicine and on the welfare of schools of medicine, it does not appear useless to enquire into the causes which led to the success, not only of the University of Edinburgh, but likewise of those of Glasgow and Aberdeen. These three universities have shared the task of training the medical practitioners of Scotland, and have been the medical schools eagerly sought after by a large number of Englishmen.

Whether we consider the career of the University of Edinburgh or of her lesser Scottish sisters, we can-

not but admit that the brilliant reputation which they have obtained amongst the teaching institutions of Europe has been due, not merely to the efficiency of the medical institution proper, but to the scientific distinction of their professors.

Poor though they have been, and unjustly neglected by successive Governments, these institutions have always possessed merits which are quite capable of accounting for their successes. In spite of their poverty, the numerous students who have flocked to them have supplied sufficient means to induce their professors to devote life-long study to those departments of science which, however important in their direct application to medicine, and however conducive indirectly to the national welfare, do not admit of being cultivated so as materially to recompense the individual worker. In short, the scientific chairs in the Scottish universities have usually been filled by men so distinguished and so well acquainted with the subjects which they taught, that the medical students who frequented their lectures had an opportunity of becoming instructed in departments of knowledge which were despised or neglected in the old universities of England, and for the teaching of which only very scanty provision existed in the medical schools of England. This undoubted pre-eminence of scientific studies has contributed most powerfully to the success of the University of Edinburgh.

Although very marked attention has been drawn to the influence which the universities of Leyden and Edinburgh exerted on the progress of medicine during the last century, it would be equally foolish and unjust

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to underrate the valuable discoveries which were being made in England, in Italy, and in France during the same period.

In England, above Hales and Hewson, John Hunter stands out as a man of scientific genius, of indefatigable perseverance, possessed of great practical resources. In Italy and in France, thanks to the labours of Morgagni, Sauvages, and Bichat, most important advances were being made in pathology and pathological anatomy.

In justice, something more than a passing allusion is due to John Hunter. National vanity apart, it may be safely asserted that John Hunter stands out amongst his contemporaries as great a British glory as Harvey or Watt, Faraday or the Stephensons. John Hunter possessed that rare combination of qualities which have, at different periods of time, made our greatest men conspicuous amongst their few rivals in other countries. He had the insight and the enthusiasm of true genius, the untiring pertinacity and the laborious patience which are at once the foundation of the success and the essence of the powers of practical men. If the founders or reformers of schools should ever need justification in their endeavours to put science to the front, John Hunter's life and labours will furnish materials for an eloquent, nay, an unanswerable, plea in their defence. It was John Hunter's scientific spirit, his burning enthusiasm which the cold blast of opposition could not chill, his passion for new truths which no additions to knowledge could satiate, that inspired him in designing and assisted him in constructing the platform upon which he raised British surgery to an unrivalled level.

While Great Britain stands out prominently as the country in which physiology flourished during the seventeenth century, and where medicine underwent great developements during the last, we cannot conceal the fact that during the present century she has, in many respects, yielded the palm to France and Germany. The position which chemistry took as an exact science towards the end of the last and the beginning of the present century necessarily led to the developement of physiology, and this reacted upon medicine with the same promptitude with which in former times the progress of anatomy had influenced practical surgery.

The scientific spirit which in France had found such splendid examples in Lavoisier and Laplace, Cuvier and Magendie, pervaded all departments of knowledge; and then was founded that great school of pathology, represented by Andral Dupuytren, Cruveilhier, Louis, and a host of others; whilst precision was, for the first time, introduced into some departments of physical diagnosis by the discoveries of Laennec and Piorry. French physiology has possessed since the commencement of the century some men of the most brilliant talents. Magendie, Flourens, and Claude Bernard form a splendid trio, and will ever hold the foremost place, after Haller, as the founders of modern experimental physiology. After a certain time, however, France had to yield her position as the chief cultivator of pathology, first to the great school of Vienna, then to that of Berlin. In physiology she had to meet as adversaries such men as Ludwig, Brücke, and Helmholtz, with the host of distinguished pupils who have been trained under their direction; and there can be no

doubt as to which of the two nations issued victorious from the conflict.

As science generally, and with it medical science, found in France the most successful workers during the first thirty years of the present century, we may stop to enquire into the causes which have led to the decay which has certainly followed, seeing that these possess special interest in connection with our present enquiry. These causes appear to be twofold. In the first place, great intellectual successes may act detrimentally upon a nation, as they do sometimes upon individuals; they may lead to so exaggerated an estimate of their own powers on the part of those who have been successful, as to discourage the exertion absolutely essential to continued progress; and they may foster a dangerous and vain contempt for the achievements of those who at one time appeared inferiors. The remarkable tendency on the part of French educationalists always to give prominence to everything French, the remarkable neglect of the study of the German and English languages, which, until lately, characterised nearly all Frenchmen, have no doubt helped very much to lower the condition of French science.

But if great ignorance of contemporary scientific literature has exerted an injurious influence, the system of centralisation which has been pursued in France since the days of the First Empire has produced no less marked an effect, stifling the scientific ardour and enervating the political energies of the nation. There had, before the time of the First Napoleon, been several universities in France, of which two, those of Paris and Montpellier, had vied with each other as medical

schools. On the establishment of the University of France, the school of Montpellier, whose foundation is said by some to have been as remote as that of the famous school of Salerno, and which had produced men of great eminence, lost her ancient position. She became, like many other provincial schools which exist in France, strictly dependent upon the one central university.

Enforced dependence has been fatal to progress, and the attempt to centralise the intellectual power of France in Paris, for the glory of the capital, has proved as surely fatal as the attempt would be, if it could be conceived by any sane person, to concentrate in one focus the commercial enterprise of this or any other country. Materially and intellectually the success of a nation must depend, like that of a family, upon the free developement of the powers of its individual members. It is by multiplying the centres of learning, so as to establish a generous rivalry amongst them, that the intellectual greatness of any country is likely to be promoted. This is the great truth which the Germans have appreciated, not merely as a dreamy abstraction, but as the very foundation of their system of national education.

It is almost superfluous to point out that in many departments of science, though not in all, the Germans have asserted their right to the first position. This is undoubtedly the case in chemistry and physiology, in histology and morbid anatomy.

If it is easy to explain the reason of the decay of scientific learning in France, it is correspondingly easy to account for its high position in Germany. The first cause which operates powerfully is the admirable

system of education pursued in the schools, where it has been found possible to teach modern languages thoroughly, and to impart an accurate knowledge of the elements of science, without neglecting the old, and most essential, subjects of a liberal education. The more philosophical methods of teaching the latter have, indeed, rendered it possible to extend the range of study without imparting to it a superficial character.

The second and most potent cause of German scientific pre-eminence is, however, to be found in the fact that in the numerous universities of Germany learning meets with opportunities of developement which do not exist elsewhere. The most ardent enthusiast of German unity must admit that the intellectual success of his country, now so evident to the world, is greatly owing to the jealous fidelity with which the elements of German greatness were developed in the separate centres of the country, and pre-eminently in its universities. Here the greatest encouragements have always been given to the most intellectual young men to devote themselves to the acquisition of learning; here they have been encouraged, not merely to become acquainted with that which is already known, but to lead in the path of scientific discovery.

It is the scientific knowledge acquired in the physiological laboratories of Germany which has chiefly led to the recent pre-eminence of Germans as cultivators of medicine. In them the German physicians have learned the methods of enquiry which, when applied to medicine proper, are tending every day, more and more, to raise it from the condition of an art to that of a science.

But has England, it will be asked, been quite inactive

during the present century, and failed altogether in promoting those studies which were so ardently cultivated in times past? The answer to such a question must undoubtedly be a negative one. Even in the nineteenth century, England has been able to boast of great physiological discoveries, whose application to medicine has certainly tended to her advancement. The discovery by Sir Charles Bell of the functions of the two roots of the spinal nerves, and that of the reflex function of the spinal cord by Dr. Marshall Hall, taken together, constitute the most important contribution ever made to the physiology of the nervous system, and have scarcely been equalled, certainly not surpassed, by any other conquest in the whole domain of physiology.

If British physiology has, even during the present century, possessed such men as Bell and Marshall Hall and John Reid (alas, like John Mayow and Hewson, too soon snatched by death from the science which he adorned!), it may be well worth considering the causes which have led to our having possessed of late no British physiological school. The success of a science in its very infancy doubtless depends chiefly upon the few great minds who, coming in the fulness of time, after a large number of facts have been amassed, are able to establish order where confusion previously reigned, and who, threading the devious paths in which their predecessors had lost themselves, succeed in striking the high road which leads to great scientific discoveries. When, however, a science has passed through the stage of its infancy, it is essential to its progress that its workers should be many and thoroughly trained, and no amount of genius on the part of a few men will

make up for the lack of numbers. In England, while the number of distinguished physiologists has been very considerable, no thoroughly organised system has existed, well fitted to train others in the methods of investigation which led to their successes. Until lately there was no institution where the same opportunities for instruction in experimental physiology existed as had been the case in England during the early years of the Royal Society, when physicists and physicians assembled at its weekly meetings, not only to impart to each other knowledge which they had obtained elsewhere, and which pertained to their several vocations, but together investigated, by actual experiment, the functions of the animal body. Parenthetically I may remark that the progress of physiology has always been influenced by discoveries in physics. Thus the early discoveries relating to respiration would probably not have been made but for the pneumatic researches of Robert Boyle; and, to quote a more recent example, our conceptions of the relations of a living being to the world in which it lives, would have been very different from what they are now, but for the establishment of the dynamical theory of heat, the discovery of its mechanical equivalent, and the establishment of the principle of the conservation of energy.

This survey of medical progress in other countries has not been indulged in regardlessly of practical applications. With scientific, as with commercial, men the great value of travel and of the study of progress in other countries consists in the materials which it supplies for forming a correct estimate of the condition of things in their own. If facts compel the admission that,

especially in the sciences which are related to medicine, and on which its real progress depends, we have much to learn from abroad, it is none the less true that our contemporary British physicians have good reason to reflect with pride on the success with which they have sustained the heritage of fame transmitted to them by Linacre, Harvey, and Sydenham. With the instinctive sense of the useful and the acquisitiveness which characterise our countrymen, the fruits of foreign investigations have been gathered up and accumulated by British physicians, who now are, probably, not second to the physicians of any other country.

That which we do want, and to the want of which we are happily growing day by day more alive, is a wider developement of schools of science and of physiological laboratories, wherein competent men shall have the opportunities essential for research, and young men may be trained in those tastes and habits of mind which are essential to the successful pursuit of science.

The laboratories of physiology which have during the last few years sprung up (at first through the influence of Sharpey and Bennett) in London and Edinburgh, and to which new ones are now being added, offer a proof that we are now fully impressed with the necessity of cultivating the science of physiology, and the success which has already attended the labours of the band of young physiologists working in these laboratories, seems to indicate that we have entered upon a period of fresh physiological activity, which marks as decided a revival in physiological studies as occurred in the mathematical and physical sciences

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some fifty years ago. We, who had boasted of Sir Isaac Newton, did little during the last century to rival such men as Euler, Lagrange, Laplace, and the host of others who formed the pride of the French mathematical school. A period, however, came when Sir William Hamilton, Faraday, Brewster, Thomson, Stokes and Andrews, Cayley and Silvester, asserted by their works that the genius and power of our ancestors had descended even to us.

Once more the opportunity seems to present itself for proving that if Englishmen, proud of past achievements, are sometimes slow in appreciating the necessity for changes to keep pace with the demands of progress, they yield to no other people as to earnestness in carrying out reforms when they have been aroused by a sense of their necessity, and have, by mature reflexion, become convinced of their wisdom. If to-day we acknowledge the German physiologists as our masters, we feel emboldened by our glorious scientific history to hope that we may soon take the place which all facts lead us to think we can hold with honour, among those who are contributing most powerfully to promote the knowledge upon which is to be based the Science of Medicine.

ARTHUR GAMGEE.

IX.

Some Historical Results of the Science of Language.

The main purpose of the science of philology is the study of the origin, the growth, and the nature of Language. It takes, for instance, the many various tongues spoken by the Indo-European nations; it traces them back to their earliest stages, as preserved to us in written records; it establishes by wide inductions the phonetic laws that determine their mutual relations; it discovers by a rigorous analysis, based on the comparative method, the principle of their inflexions; and so at length builds up piece by piece the language of the days of their primeval unity. Even here it does not stay its hand, but it pushes on by bold but sober and strictly scientific processes, until it discovers in a score of pronominal elements and a hundred or two of monosyllabic roots, of a vague and purely physical meaning, the rough materials out of which the half-unconscious toil of ages has woven the raiment of the sublimest poetry and the most profound philosophy. This stage is one of peculiar interest; for just as the biologist finds the key to many of his most perplexing problems in the careful study of the embryo, so, from this rudimentary state of language, the philologist

gleans many a helpful truth to guide him to the laws that rule in fully developed speech. But his goal is not yet reached. He has to determine, if this be now possible to human sagacity and learning, how these roots originated: to discover whence came the first beginnings of language, which at present are the ultimate results of his analysis. This part of the work of the science of language is still far from completion. No theory has as yet received the adhesion of so large a proportion of competent judges that it may claim to rank as a scientific truth. But the ground is being cleared of encumbering delusions. The theory of an original revelation of language in any completed form has passed into the limbo where rest the similar fancies of a contemporaneous creation of fossils and the rocks in which they are found embedded. The mystic doctrine of "phonetic types," to which the authority of the most popular English writer on the science of language long appeared to give an adventitious weight, is now discarded, somewhat unkindly, by the illustrious scholar who brought it into general notice. The theory of the origin of language in mutual convention broke down as completely as the corresponding theory with regard to the origin of society, so soon as men really began to endeavour to conceive for themselves the nature of the conditions which they postulated. Philologists, if not yet wholly at one upon the solution of the problem, are all but universally agreed upon the line in which we must look for it. It is evident to every sober thinker that it must reside in some operation of the imitative principle, quickened in all probability by circumstances which we

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are able to a certain extent to reconstruct, and aided, at first very largely but always in lessening measure, by the language of sign and gesture.

But while this study of the nature and origin of language, and so ultimately of the powers and limits of the mind of man, is the proper and peculiar function of the science of philology, the results to which its investigations lead us are not limited to the field that is thus marked out. The proper aim of the chemist is to discover the constitution of the material world, to resolve it into its ultimate atoms, and to learn the nature and the mutual relations of the elements at which he arrives. If all his researches led to nothing more than this, they would yet be fully justified. For knowledge is worthy of quest for its own sake, and a life is not ill-spent which has for its object the conquest of something of the vast unknown, even though the territory gained seem at first to be poor and barren. But the history of chemistry is full of instances in which new compounds, formed solely with the purpose of extending the completeness of theoretic science, have been found to possess the most valuable properties. Disease has been made less fatal and pain less terrible, the manufacturing arts have become far more productive, and their results more permanent and beautiful, from investigations that were conducted in the laboratory with no utilitarian purpose. And so it has been with the science of language. While pressing on its way to its proper ends, it has opened to us in its onward progress many different fields of great fertility. One of these only I propose to enter on the present occasion.

Few questions have more interest for us than the early condition of man. Apart from the natural desire to know whence and how our race, and more particularly that division to which we ourselves belong, came into its present position on the earth, and reached its present stage of culture, the very obscurity of the problem lends it additional attraction. History can carry us back but a very little way. For five-and-twenty, or at most but thirty, centuries its torch can give us light; but then it is lost to view in the mists of time, or its feeble flickerings cannot be distinguished from the will-o'-the wisps of legend. To palæontology, guided and interpreted by the laws that are found to be ruling in life at present, we may look with hopeful confidence for the history of the origin and developement of the physical form of man. But a great gulf still remains uncrossed. When and how it is to be bridged can be discovered only by the converging testimony of several sciences, and among these philology takes an important place. It is true that the evidence which it gives is limited in its range, and on some of the most interesting points it is silent. With regard, for instance, to the question of the unity of the human species, I believe that its testimony is purely negative. It has been fairly summed up thus: "If the tribes of men are of different parentage, their languages could not be expected to be more unlike than they in fact are; while, on the other hand, if all mankind are of one blood, their tongues need not be more alike than we actually find them to be." * Whatever evidence may

* Whitney, *Language and the Study of Language*, p. 394.

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be brought from other sources on either side of this great question, the science of language here is mute. Again, it can tell us nothing at present of more than a section of mankind. It is true that the two great families on which alone it can venture to pronounce its judgment clearly, include with hardly an exception all the races that have ever contributed largely to human progress. But it is equally forbidden to science and to religion to confine their attention to the wise and the strong, and it is a source of deep regret that the matter with which philology has to deal is in many cases so weather-worn and fragmentary that its interpretation of it must ever remain but tentative. Even in the case of the Semitic languages, so far as the best authorities inform us, but little has as yet been done towards deciphering the indications offered by their structure and mutual relations. There is every probability that the nations which spoke them at one time formed a united people; and M. Renan has endeavoured, with, at all events, some show of plausibility, to determine the mountain-region from which the successive waves of Semitic nomads rolled down on the Cushites of the plains.* Some hints may be gleaned of their inferiority to those whom they invaded in material civilisation, and of their vast superiority in moral and religious elevation; but the comparative study of language tells us but little of their actual con-

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* Cp. *Histoire des Langues Sémitiques*, pp. 29. 480. But E. Schrader, in the *Zeitschr. der Morgenl. Gesellsch.*, xxvii., pt. 3, brings much evidence to show that Northern and Central Arabia formed their original cradle, and that it was hence that they dispersed in all directions.

dition. It is possible that they were once united to the Indo-European stock; but if it was ever so, it is certain that it must have been at a time when their common developement was but feeble and rudimentary. It may be that a handful of roots will still remain to point to a common origin when we have deducted all the coinciding forms which are due to chance, or to borrowing at a later stage. But the whole grammatical structure of the Semitic tongues is so unlike that which we find in the sister Indo-European group that we cannot suppose anything worthy of the name of language to have been ever shared in common by the forefathers of the Hebrews, the Persians, the Phœnicians, the Greeks, and the Germans.

So soon, however, as we limit our view to the languages sometimes, though hardly accurately, known under the name of Aryan,* the science of language furnishes us with copious and trustworthy results. Indeed, the scientific method of philological research had no sooner been introduced than it furnished us with a new historical fact of capital importance. So long as philologists confined themselves to a study of the superficial resemblance of languages, without any trustworthy test of those which were really akin, and

* The evidence that the name "Aryan" was ever used by any but the eastern division of the Indo-European family is extremely slight, and the soberest philologers limit its application to these. Cp. Peile, *Introduction to Greek and Latin Etymology*, p. 30. It is much to be regretted that Mr. Freeman, in his *Comparative Politics*, has lent the weight of his great authority to a still more unfortunate use of the word. In his application of it he practically excludes all those nations of whom we have sufficient reason to believe that they used the word as their national name.

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without any but the loosest notions of the phonetic laws which ruled in their mutual relations, their work was essentially unscientific and fruitless. The history of the natural sciences furnishes us with more than one analogy. So long, for example, as zoology and botany had for their object the grouping of animals and plants according to their outward likenesses, no true developement was possible. The materials for science were accumulating, but biology was as yet unborn. This dates its origin from the first conception of morphological classification: it was placed on a sure foundation when a common typical structure, and not any vague general resemblance, was made the test of relationship. Just so the science of language dates from the day when Bopp first conceived the idea of bringing the test of the method of inflexion to bear upon the question of the affinity of tongues. As a magnet plunged into a heap of medley fragments sifts out any particles of iron that may lie in it, by drawing them all to itself, so this unerring instrument severed at once from the undistinguished medley of dialects all that possessed any kinship. A comparison of various languages shows that almost any amount of similarity in isolated words is quite compatible with entire distinctness of origin. No one would think of arguing from the fact (quoted by Dr. Farrar *) that the Polynesians and the modern Greeks denote the eye by exactly the same word, *mati*, any connection between Athens and Tahiti. But an identity of inflexion can only be interpreted in one way. It is conceivable that

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* *Families of Speech* (new edition), p. 48, *note*.

one nation should have borrowed from another a portion of its vocabulary, or that many words found in the one should happen to agree in form with words of identical meaning belonging to the other, either from the independent action of mimetic word-formation or by pure accident; although it is evident that the probability of this diminishes vastly when several distinct languages are thus found coinciding, when the number of roots in which they agree constitutes a large proportion of the total vocabulary, and when the words which are phonetically equivalent denote those rudimentary ideas with regard to which borrowing is almost wholly out of the question. But all these indications, cogent as they may be, are inferior in scientific certainty to those which are afforded by considering the method of inflexion. It is barely possible that the greater number of the European nations and some of the most important tribes of Asia should have happened by accident to denote such ideas as *father*, *mother*, *brother*, *sister*, *cow*, *horse*, *speak*, *bear*, by words that can be shown to have been originally identical: it is just conceivable that they should have borrowed such words one from the other. But it is not in any way possible that they should have borrowed, or by chance devised independently, the method of denoting what we call the first, second, and third persons, by the use of *m*, *s*, and *t*, respectively, of indicating plurality by a suffixed *s*, or the conditional mood by an inserted *ja*. Coincidence in points like these admits of no other explanation than that they are all descended from a common primitive language. But the existence of a common language points most plainly to an original unity of nationality.

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It is true that in history we have instances of a language adopted by a nation wholly alien in blood from those by whom it was originally spoken, and unconnected with them in their early national life. But it may be readily shown that in the case of the Indo-European peoples none of the conditions were present that make such an adoption possible. There can be no question of conquest, of immediate juxtaposition, of extensive colonisation, or of the attractions of a higher civilisation to explain the resemblances between Sanskrit, Zend, Greek, Italian, and the various Teutonic, Celtic, and Slavonic languages. Hence we are brought irresistibly to the conclusion that the ancestors of, at all events, the bulk of those who speak these languages or their derivatives, formed at one time a united nation, which had found for itself an organ of intercourse intelligible to all in common. It matters nothing that history is silent as to any such original unity, that the all but unanimous voice of tradition ignores or contradicts it. The facts are there, dim and often wholly illegible, in our modern speech, like the image and superscription on a coin that has been worn by centuries of usage, but coming out sharp and clear whenever we can find them fresh from the mint, and to be restored with certainty by the comparison of specimens in various stages of preservation. And the facts will allow us to accept no other conclusion.

But is it possible for us to learn from language anything more of this shadowy people that looms upon us out of the mists of the ages, beyond the fact that it is there? Let us consider for a moment what is the essential nature of language. Men find or fashion words to express their feelings or their knowledge.

Where there is no idea, there, we may be sure, no word exists to express it. Suppose, then, that we can show in the common Indo-European language words denoting certain things or notions, does it not follow immediately that the things and notions must have been known to the united nations? If, therefore, we can find, by a careful analysis of the languages that belong to this common stock, those words which they once possessed in common, it is evident that we shall have the materials for a picture of the physical, the intellectual, and even to some extent the moral and religious life of their early unity. The attempt to draw this out has been made more than once since the appearance of the "path-breaking" works of Bopp and Grimm. The earliest collection of words significant for the history of culture (so far as I know) was given in Eichhoff's *Parallèle des Langues de l'Europe et de l'Inde* (Paris, 1836); but although the leading principles of comparative philology were by this time firmly established, scholars had had but little practice in their application, and many minor points were still left in uncertainty; so that Eichhoff's work, meritorious as it was, stands far behind the present position of science. The next essay of any importance in this direction was that of A. Kuhn, published in Weber's *Indische Studien*, vol. i. pp. 321-363 (Berlin, 1850). In this article Dr. Kuhn gathered with great care and diligence a large number of the significant words, and handled them with scientific precision. The main results of his investigations were introduced to English readers by Professor Max Müller, in his justly-celebrated contribution to the *Oxford Essays* for 1856. But the principal

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value of this essay lay in the portion that dealt with comparative mythology, and the few additions made by Professor Max Müller to the sketch of the history of culture previously given by Dr. Kuhn, have not found favour in the eyes of scholars.* A few years later M. Adolphe Pictet entered into an elaborate discussion of the whole question in his treatise entitled *Les Origines Indo-Européennes ou les Aryas Primitifs: Essai de Paléontologie Linguistique* (2 vols. 8vo., Paris, 1859, 1863). This work is not without considerable merits; it collects and arranges conveniently the whole of the materials at hand, and displays great ingenuity in its combinations; but unfortunately that rigorous sobriety of judgment which is nowhere more needed than in philological investigations is almost wholly wanting. Far too much weight has been given to the brilliant guesses of that most learned and most erratic of philologists, Professor Pott; and the extent to which M. Pictet sometimes strays from the most approved methods of scientific investigation may be seen from the second rule which he lays down for himself: "Partir toujours du mot sanscrit, s'il existe, soit pour arriver à la restitution du thème primitif, soit pour en découvrir l'étymologie probable." To accept this rule is to maintain that nothing can be a family trait which is not present in the eldest sister, even though it be conspicuous in all the rest of the children. No philologist of repute would hesitate to admit that there is

* I refer especially to the extent to which he assumes agriculture to have been familiar to the united Indo-European people. Cp., *inter alia*, Mommsen, *History of Rome*, vol. i. p. 16 (English translation), and Fick, *Ehemalige Spracheinheit*, p. 280.

hardly an Indo-European language which does not occasionally preserve an earlier form than any occurring in Sanskrit.* These defects, together with a tendency, which we may perhaps call national, to build far-reaching hypotheses on a very slight basis of fact, render it necessary to use M. Pictet's work with very great caution. But to one who will so employ it, the book affords many suggestive combinations and striking *aperçus*. Meanwhile the subject was not neglected in Germany: numerous contributions to Kuhn's *Journal of Comparative Philology* added fresh materials and sifted the old with critical care and severity. It is true that the process had a negative as well as a constructive tendency. If much was added, something was also taken away. Seductive etymologies, some of them apparently pregnant with interest, were shown to be inconsistent with the phonetic laws that were becoming from year to year more precisely defined and more surely established.† But the loss was more than compensated by the gain, and scholars were well content to sacrifice some few scattered and unimportant points for the sake of the increased security of tenure with which they held all that was really worth contending for. The total outcome of the labour which was spent upon this branch of the science of language during the

* For example, the root which we have in *loc-utus* and in *ἔ-λακ-ον*, occurs in Sanskrit only in the form *lap-ami*. We have to resort to the Church Slavonic to find both the original consonants preserved in the root *rek*. It is perhaps more than a coincidence that we find the Gypsies using the form *roker*, "to speak." Paspati, *Les Tchinghianés*. Cp. Curtius, *Griechische Etymologie*, p. 506.

† Cp. the treatment of the word *vidua* in Max Muller's Essay (*u. s.* p. 21), and in Curtius, *Griechische Etymologie*, p. 39, *note*.

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twenty years which followed Kuhn's suggestive paper, was gathered up by Dr. August Fick, of Göttingen, in his *Wörterbuch der Indogermanischen Grundsprache* (Göttingen, 1868); and a second edition of this work, with considerable improvements, was published three years later under the title of *Vergleichendes Wörterbuch der Indogermanischen Sprachen.*' * This book enables us to give an answer, more confidently and completely than was previously possible, to the question raised already, whether we know anything more about the united Indo-European nation than the bare fact of its former existence.

But before the attempt can be made to draw any picture of its early condition, it is necessary to consider the limits within which our method of research is to be trusted. The guiding principle is that when a word is found to be present in two or more of the cognate languages, the idea which it denotes must have been familiar to the united nation. But in applying this principle several precautions are necessary. In the first place, it is clear that it is needful to exclude most carefully every instance in which there is even the possibility of borrowing by one language from another. Hence the Keltic languages, for example, are of comparatively little service to us, because we know them, for the most part, only at a period when the nations

* Dr. Fick's collections served to supply most of the material for the present paper: but before it was completed, Dr. Fick himself gathered some of the fruit of his labours into a more attractive shape than the columns of a dictionary, in his recent work, *Die ehemalige Spracheinheit der Indogermanen Europas*, and something has been added from this book also.

speaking them had been subject to Roman influence, and therefore they abound in words that are not survivals from a primitive condition, but later appropriations from Latin.* In the second place, we must be careful to exclude all meanings of words that we have good reason to suppose developed from the primary meaning of the root since the break-up of the early unity. Words have sometimes acquired in two or more languages the same extension of meaning wholly independently: and it would be dangerous to draw from their later usage any inference with regard to the united nation. For instance, a root originally meaning to *scratch* or *furrow* may have been employed quite accidentally in later times by two or more nations in common to denote that particular kind of significant scratching or furrowing which we call "writing." But it would be dangerous, and in fact, as other evidence shows us, erroneous, to argue that writing was practised by the early Aryans.† Again, it is evident that

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* Cp. Westphal, *Vergleichende Grammatik*, p. 13. In the list of words by which Professor Newman (*Regal Rome*, c. ii.) endeavours to show the close connection between the Latins and the Kelts, we find (to say nothing of many that have their representatives in almost all the Indo-European languages) the names of the ape, the peacock, and the buffalo. On the general question of this close relation cp. Ebel's *Keltische Studien*, and *Beitr.* i. 429, with Schleicher, in the *Rheinische Museum* for 1859.

† Cp. Curtius, *Gr. Etym.*, No. 170. Fick, *Vergl. Wörterb.*, p. 358. Professor Max Muller (*pace tanti viri dixerim*) appears to have neglected this caution in his remarks on "Arian agriculture" (*Oxford Essays*, 1856, p. 27). Cp. Fick, *Ehemalige Sprach.*, pp. 288–289, and Kuhn, *Ind. Stud.*, i. pp. 353–399; but on the other hand, Benfey, *Geschichte der Sprachwissenschaft*, p. 597.

So Mr. Ferrar writes (*Comparative Grammar*, vol. i. p. 35), "*Scribo* exactly corresponds to γράφω, with the exception of the prefixed *s*,

the local range within which a word is found occurring is of great significance. If a form is present only in Zend and Sanskrit, this argues little, and, indeed, almost nothing, for its claim to belong to the primitive stock: it is highly probable that it is a growth subsequent to the separation of the Aryans proper from the Indo-Germanic Europeans. On the other hand, if a word is common to Erse and Sanskrit, the fact is just as significant as if it were actually found occurring in every Indo-European language. The possibility of borrowing is so entirely excluded, that there is the strongest evidence in favour of the word being an original possession of both, and therefore of all. But, once more, we must be very careful not to arrive too rashly at any negative conclusion. Languages, in their earlier stages especially, abound in synonyms, and it often happens that in the struggle for existence one of these survives in one branch of the language and another in another. For example, it would be very unsafe to argue that in the days when the Italians and the Germans were yet one people in the forests of Central Europe the horse was unknown to them, because the Latin *equus* has no connection with the English *horse*. The fact is that here, of the two synonyms, both of which were probably used by the

which proves either that writing was known to the Greeks and Italians while they still formed one people, or that *scribo* was borrowed from the Greeks in very early times, when φ was still soft." It is surely much more probable that the root *skrabh* was used with a certain vagueness of meaning in primitive times. It is not recognised by Fick, but it seems to be only a by-form of *skarp* with a kindred meaning. A trace of its primary meaning is retained in Catull. (Ellis)

united nation, the one which connotes the speed of the animal (*equus* = primitive *akvas*, from the root, *ak*, "sharp, fast") was retained by the Southern Europeans, as also by the Eastern Aryans, while the Teutonic nations have come to prefer the mimetic name which described it as "the neigher."*

Again, we must remember that our knowledge of the earliest forms of several of the Indo-European languages is extremely meagre. We are somewhat better off than the palæontologists. They have as yet been able to open only a very few pages of the record which they have to decipher, and those have been chosen for them almost entirely by chance. But, in our case, too, many of the original branches of the Aryan language have been, doubtless, wholly lost; while others of primary importance, like the Mœso-Gothic, the Old Prussian, and the Church Slavonic, are known to us only from a single fragment each. Hence it is clear

* O. H. G., *hros*; O. Eng., *hors*, M. G., *ross*, from the root which appears in the Skt. *hrésh*, "neigh." Cp. Grimm, *Geschichte der Deutschen Sprache*, p. 22. The forms corresponding to *akvas* do, however, appear in Goth *aihvus*, according to Grimm, *Ueber das Verbrennen der Leichen*, p. 28, O. H. G., *ehu*, O. Sax., *ehu*, surviving, as Dr. Morris thinks (*Historical Accidence*, p. 72), in *nag*. The more common German word, *pferd*, is a corruption of the late Latin hybrid, *paraveredus*, from which we have *palfrey*: cp. Brachet, s. v. *palefroi*, and Grimm, *Geschichte*, p. 22 (ed. 2), where the intermediate forms are given. Dr. Farrar (*Families of Speech*, p. 48) expresses his belief that *pferd* is traceable to a Sanskrit root, but he does not undertake the feat of showing this. He adds: "The root 'horse' may allude to the spirit of the animal (*karasa*, what passion')" This he derives from M. Pictet, "the highest of authorities in everything which concerns the primitive Aryans." It is hardly necessary in disproof of such a theory to refer to Curtius, *Etym.*, p. 50 (E. T.).

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that we have not the materials for definite conclusions on every point of interest. Further, it is to be remembered that the matter with which we have to deal, under certain conditions as imperishable as diamonds, is in other cases extremely exposed to decay. Suppose a crew of English sailors wrecked on an island in the Pacific, and the offspring that they might have by native women living there for one or two generations, destitute of letters and cut off from the rest of mankind; the first comers would retain almost unimpaired the stock of English brought with them—a very small portion, we may notice in passing, of the total wealth of the language, inasmuch as probably no ordinary individual is wont to employ more than two or three thousand out of the hundred thousand words which go to make up our whole vocabulary.* But the language of the next generation would be far more limited. Probably the children would never hear the names for horses, cows, sheep, or dogs; for wheat and barley, oaks and beeches, palaces and castles, prisons and hospitals, or a thousand other things, of which they might never even conceive the existence. And yet it would be incorrect for a subsequent discoverer of an island so peopled to assume that the population originally came from a country where none of these things were known. A word is not a living thing with a right of existence on its own account. It is only the dress in which a conception presents itself to the outer world: and if once the conception is dead, the word must share its

* Marsh, *Lectures on the English Language*, Lect. viii. § 6: but cp. Müller's *Science of Language*, p. 253.

fate. It is highly probable that some of the straggling branches of the Indo-European unity passed through stages of degenerate civilisation, in which many of the ideas that they brought with them from their early home perished for lack of usage. And when they were re-created or borrowed from neighbouring tribes, they appeared in a guise wholly different to that which they once had worn. Negative conclusions, therefore, must be drawn with the greatest caution.

Such are some of the principal limits within which our method of research is applicable. It is impossible in the space of a brief essay to demonstrate how, in every instance, they have been properly observed, but it is hoped that in the following sketch they have never been transgressed, and that every touch inserted is sanctioned by the most rigorous inductions of science.

Far, far away, in the mists of a distant past, at a time and place of which we have only faint and uncertain indications,* we can catch clear glimpses of the primitive "Aryan" people. The state of nomad vagrancy, if ever they fell into it, is over for them

* M. Pictet's first volume is devoted to the attempt to determine, from the names of the minerals, plants, and animals known to the united nation, the situation of their earliest home; but the soundest philologists do not consider his reasonings conclusive. All that can be said is that the region which he decides upon—the ancient Bactriana—is perhaps more probable than any other. Benfey (*Geschichte*, p. 598), on the other hand, thinks that the earliest home must have been in Europe, arguing mainly from the names of the lion in the Aryan (*i.e.* Asiatic) and European languages, but his arguments seem very weak.

now; they are dwelling in permanent wooden houses, gathered into separate villages, or even towns.* The basis of the national life is the family in its purest form: polygamy and the slavery of woman are unknown; the husband is acknowledged as lord and master, but the wife is no less lady and mistress;† and the abundant names for various kinsfolk bear witness to the strength of the family tie, that stretches far before it is broken. The father's strong protecting arm, the mother's watchful care, are brought out in the names that they severally received.‡ The word for "son" probably means nothing more than "child;"§ the word for daughter, however, seems to bear the germ of a pretty little idyll embedded in it. It can hardly be anything originally but "milk-maid;"|| and thus gives us a glance at once into the simple manners and the pastoral condition of those early times. The

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* Cp. Skt. *purî* or *pura*, with πόλι-ς and the Lith. *pili-s*.

† Cp. Fick, *Wörterbuch*, p. 116, s. vv. *pati*, *patnyâ*. *Spracheinheit*, p. 266.

‡ It is idle to attempt to sever *pâtar* and *mâtar* from the numerous other derivatives from the roots *pa* and *ma*: but so much may be fairly granted to the defenders of the mimetic origin of these words, that of all the numerous appellations which might have been (and probably were at one time) given to parents, those survived which in the "struggle for existence" recommended themselves as the easiest for the utterance of children.

§ The root *su* is 'to beget:' and the suffix *-nu* is so commonly used with a passive as well as an active force [cp. Schleicher, *Vergl. Gramm.*, § 223, a] that it is hardly legitimate to accept Benfey's attractive notion that the son was regarded from the first as the future father of a family: but see Fick, *Spracheinh.*, p. 267.

|| So Lassen, Pictet (ii. p. 353, where, however, much is erroneous), Max Müller (*Chips*, ii. 26), and Curtius (*Gr. Etym.*, No. 318). Bopp (*Verg. Gr.*, i. 299) and others explain "weiblicher säugling; but there are reasons against this.

brother is the "sustainer" of his sister,* while she seems to be denoted as "his very own," or it may be, perhaps, "his delight." The son's wife enters entirely into the family of the husband, and his parents become to her "her own lord and lady;"† on the other hand, the absence of any common Indo-European term for son-in-law shows that a marriage-alliance did not necessarily bring the two households concerned into any very close relations. Another "Indo-Germanic idyll," as Delbrück calls it, is revealed to us in the name given to the husband's brothers (especially the younger ones), the "playmates" of the bride.‡ In the house the father was apparently the absolute monarch; and he represented it in all its relations to the state, both civil and political. A community consisting of several families formed the clan (*vik*), which had its own chief (the *vik pati*). Besides this "lord of the clan" we find another appellation occurring, that of "ruler" (*râgan*); but language does not enable us to determine precisely the relation in which these stood each to the other. It is a natural conjecture, however, that the "ruler" was the chief of the nation, and that the "lords of the clans" were subordinate nobles.§

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* Another derivative from the same root is a name for "husband" in Sanskrit.

† Pictet's interpretation of *Svakuras* (ii. 370) is sanctioned by Curtius and Fick.

‡ For the connection of δαήρ and *dêvar* (primitive form *daivar*) with the root *div*, "to play," cp. Curtius, *Gr. Et.*, No. 257. Otherwise Fick, *Wörterbuch*, p. 96.

§ This is perhaps more probable than Max Muller's explanation (*Chips*, ii. 40, cp. p. 329) that the *vik* denoted originally the people, and that *vikpati* thus meant "lord of the people." This theory inadequately explains the wide-spread use of the stem *vaika* in the sense

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The land is the common possession of the township, if we may judge from the survival of this usage, in all Aryan communities; but it can hardly be said to be tilled as yet, though the beginnings of agriculture are visible. It is possible that the wild barley or spelt was gathered and roughly bruised for food; but nothing more than this can be seen indicated in the evidence of language.* On the other hand, the tending of cattle was the main occupation of those early times. One name whereby they were known, the tethered, shows that they were domesticated; others are plainly mimetic, but some point to the fact that the value of cattle lay mainly in the food they furnished; and the way in which the various appellations enter into derivatives or metaphors belonging to the earliest stages of the kindred languages is a proof of the importance attached to them as an article of property.† The horse, the

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of village. Apparently Professor Max Müller would pass at once from the meaning of "house" to that of "people," ignoring the Lat. *vicus*, and the *-wich* of so many local names. The name of the third caste the *Vaiçyas* seems better translated "villagers" than "householders:" cp. the Latin use of *paganus*, e.g., Plin. *Ep.* x. 18, § 2, "et milites et pagani;" Juv. xvi. 34; Heraeus on Tac. *Hist.* i. 53, and id. iii. 24, where the *pagani* of Antonius is equivalent to Cæsar's *Quirites* (Lucan, v. 358).

* The derivation of εὐλάκα is much too doubtful to be pressed into the service, as is done by Fick, *Spracheinh.*, p. 280; and the forms quoted by Max Müller (*Chips*, ii. 45) are put entirely out of court by the fact that they are all drawn from European languages. He would not probably, himself, lay any stress on the occurrence in Sanskrit (with its primitive meaning of "white") of the root which is applied (apparently only in the Germanic languages) to denote "wheat."

† Cp. Max Müller, *Chips*, ii. 26–29. Pictet (ii. 36–72) has much valuable matter, but it is used uncritically. Who can believe, e.g., that *gaudeo* is properly "posséder des vaches"?

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sheep, the goat, and the pig, are already familiar, and stalls are built for their protection.* The first of these is used for draught, and waggons of various kinds are employed; but riding is apparently unknown. Sheep are kept chiefly for the sake of their wool, which is used for clothing, and possibly derived their usual name from this.†

The dog is trained to aid the shepherd; the yard is filled with geese, the "buzzing" bees are robbed of their honey, whence the favourite drink is made.‡ The "thievish" mouse § is found in the homestead, and "a glorious time he must have had of it there" (to quote the words of Kuhn), for cats are still unknown. We can even see how our forefathers were plagued with adders, caterpillars, and ants, and other insects whose attentions are more persistent and even less agreeable.‖ Their eyes are quick to note the various forms of nature; birds of many kinds bear names, for the most part strikingly appropriate, and in the vege-

* Few probably recognise a word of great significance for primitive history, when they read in Juvenal of the "stantis convicia *mandrae*;" fewer still perceive it in the title of the Greek *Archimandrite*. Cp. Fick, *Wörterb.*, p. 148.

† Cp. Curtius, *Gr. Et.*, p. 583, note; Schleicher, *Compend.*, 385; and Fick, *Wörterb.*, pp. 17, 18.

‡ It is true that the meaning of the Skt. *madhu* is not limited to honey or mead, but is extended to any pleasant drink, and that the Zend *madhu* like *μέθυ* rather denotes "wine," but these meanings are probably derivative, especially as the vine seems to have become known to the Eastern and Western Aryans independently (cp. Curtius, *Gr. Et.*, No. 594, against Pictet, i. 254). The kindred names for "wax" belong wholly to the European languages, but this can hardly fail to be accidental, as the bee was evidently well-known.

§ The derivation of the name is still clear in Sanskrit. Curtius, No. 483.

‖ Cp. Fick, *Wörterb.*, s. vv. *padi*, *kari*, *skapa*.

table world the pine, the beech, the birch, the hazel, and possibly the poplar, with the cabbage and the cucumber, have left their marks on language.* Milk and flesh seem to serve as the main articles of food; but the former is prepared in various ways; the latter is never eaten raw, but is sodden or broiled on coals. Of the wild fruit and berries, to which *à priori* theorists have assigned so large a part in the sustenance of early man, the comparative study of language tells us nothing. Clothing is furnished by the flocks, whose wool is spun and roughly woven; perhaps too hides are sometimes dressed and worn. All go bareheaded, so far as we can now discover, but their feet are guarded by a kind of buskin, and ornaments are not wanting, of which the collar or necklace appears to be the favourite.† Three metals only are known—the bright yellow (gold), the white (silver), and the red (copper), denoted collectively by a name which was afterwards specialised differently by different nations.‡ Of working in stone we find no trace, but the craft of the carpenter is highly esteemed, and seems to attain to no mean completeness. With his bronze tools, among which the axe is prominent, he builds houses of timber and fashions doors for them;

* Undoubtedly many other trees and plants were known, but their names cannot be clearly brought into comparison. Pictet's treatment of this part of this subject is highly unsatisfactory.

† Cp. Fick, *Wörterb.*, s. vv. *mani* and *munda*.

‡ This seems the most satisfactory way of accounting for the various senses given to the derivatives from the primitive *ayas*. Cp. Pictet, i. 152. Benfey, however (*Geschichte*, p. 598), explains the facts otherwise. The evidence by which Max Müller persuades himself that "there can be no doubt that iron was known" (*Chips*, ii. 47), and apparently (though his language is not clear) was named *ayas*, appears very inadequate to support the assumption.

constructs waggons with wheels and axles, and even frames some kind of rough canoe, to which, however, masts, sails, and rudders were wanting.* The potter too plies his art, and furnishes pots and beakers ; the curious fact that the same word (*kumbha*) is used for *pot* and for *head* leads Fick to fancy that the skulls of slain enemies were used sometimes for drinking-vessels, as with the ancient Germans ; but the analogy of the French *tête* and the Italian *testa* points rather to a derivation of the latter meaning from the former,† perhaps at first by way of jest or slang. The beginnings of art are faintly adumbrated by the words for painting and adorning.

War is of course not unknown, but from the evidence of language alone we cannot determine the enemies with whom it was waged ; the earliest remains of Aryan literature incline us to find them in the hordes of wild Turanian horsemen, by whom our forefathers appear to have been surrounded on every side, and who were known by them as the evilly-disposed (*dusmanas*) or the ravaging (*dasjas*). We cannot find any traces of defensive armour ; but swords of bronze, bows strung with the sinews of animals, and possibly lances, served as weapons of offence. The healing art is already practised, but it seems to have been almost wholly confined to the cure of wounds, and to have consisted largely of religious incantations.

Roads were opened, at least in some rude fashion,

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* Cp. Fick, *Wörterb.*, s. vv. *paraku*, *dama*, *rata*, *kakra*, *nabha*, *aksi*, *nau*.

† In Auson., *Epigr.* lxxii., we catch the word in its transition stage:

> 'Abiecta in triuiis inhumati glabra iacebat,
> Testa hominis, nudum iam cute caluitium.'

and barter was carried on; but, as might have been expected, we find no trace of money. The recognised standard of value, as natural with a pastoral people, was cattle, and this method of estimation has left its traces in almost every Indo-European language. Thus "rupee" (Sanskrit, *rûpya*), which derives its modern meaning from the wider sense of "bullion," is derived from *rûpa*, "cattle," and numerous compound words in Sanskrit referring to wealth or poverty, contain the root *gav* (our *cow*). In Homer, as in the early times of the Romans, in the Brehon laws of Ireland, and the Vendidad of the ancient Persians, value is estimated in cattle. The Latin *pecunia* and *peculium* are familiar relics of the same condition, and in the Gothic Scriptures of Ulfilas, *faihu* (properly "cattle") is always used for wealth or money.* From this we have our own word "fee," with the early English "maiden-fee" for dowry. It is very possible that the numerous Sanskrit names of measures, which contain the same root *gav*, point to a common Indo-European usage.

It is certain that the decimal system, based as it is on the natural fashion of reckoning on the fingers, was already in use, and the numerals that we employ to-day, so far as a hundred, were, with hardly an exception, already familiar.† The year was apparently divided

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* Cp. Mark x. 22, "vas auk habands *faihu* manag:" so *faihu -frikei*, *-gairnei* or *-geigo*, "avarice," *faihu-skula*, "debtor," and *faihu-thraihns*, "mammon" (Luke xvi. 13).

† The words for "a thousand" (Skt. *sahasra*, Zend *hazarisa*, Goth. *thusundi*, Gr. χίλιοι, Lat. *mille*, Erse *mile*, Cymr. *mil*) with the exception of the first two and the last three, seem to be unrelated. Fick's attempt to connect χίλιοι (through Æol. χέλλιον) with *sa-hasra* will hardly justify us in assuming a common primitive form, *ghasra*

into only three seasons—the spring, the summer, and the winter;* the moon, which was especially named "the measurer," by its changes, marked the months, denoted originally only as moons. It is perhaps a sign of the impression which the gloomy period of the year made upon the quick sensibilities of a people, living much in the open air, that time seems generally to have been counted by winters.†

Of the amusements of our Indo-European forefathers it is not possible now to form any definite conception from language; but as the Rigvêda and Homer agree in their references to the taste for gambling, it is at least possible that games of chance were familiar.‡ There are indications of the use of the dance and song, either in the worship of the gods or in commemoration of the deeds of valiant heroes, and some

(*Worterb.*, p. 70). *Mille* is probably "a confused heap" (cp. Corssen, *Krit. Beitr.*, p. 311).

* *Vasara*, "the time of brightness," *sama*, of more doubtful meaning, and *ghima*, "the time of snow." My learned colleague, Professor Theodores, connects the very obscure *Himmel* (Goth. *himins*) with the last word, as denoting "the quarter whence the snow comes." But can a Sanskrit *h*, when it represents a primitive *gh*, appear in Gothic or German as *h*? *Hyd* for *kard* = *hairts* and *herz* is of course not parallel, and even this seems isolated.

† In the *Rigvêda çatam himâs*, "hundred winters," is the common expression for a century (Pictet ii. 605); and Ulfilas translates ἔτος by *vintrus*. Cp. Matt. ix. 20, Luke viii. 42, "unte dauhtar ainoho vas imma sve vintrive tvalibe;" so *tvalibvintrus* in Luke ii. 42. This is the best explanation of the Lat. *bimus*, *trimus*, &c.: cp. Curtius, *Gr. Etym.*, No. 194.

‡ It is not certain that the πεσσοί or ἀστράγαλ of Homer (*Od.* i. 107; *Il.* xxiii. 88) were games of chance, but it is probable that they were sometimes. Cp. K. F. Hermann, *Privatalterth.* § 54. Becker, *Charikles* ii. 305, *Gallus* iii. 325 340, and Bahr on *Herod.* i. 94. Pictet's discussion of this question is very unsatisfactory.

signs that the bard already held a position of exalted honour.

The ideas of morality which are current are still simple, concrete, and almost sensuous. *Honour* derives its name (*gar-as*) from the shout of applause that sets it forth; *fame* is the audible utterance (*kravas*) of approval; the *friend* is one who follows steadily, or perhaps simply one who is attached; *sin* is a missing of the path, a stumbling, or defilement (*sakya*);* *truth* (*satia*) and *goodness* (*vasu*) are described emphatically as "things which *are*."† Law is recognised as that which is ruled by the chieftain, and transgression brings with it a penalty whose name reveals to us that it consisted most commonly of a fine.

The notions of the unseen world bear the same child-like stamp. The relations that hold in the families of mortal men are freely transferred to the realms of the deathless spirits, who are regarded as pure and mighty beings.‡ Just as the earthly father rules in a household which forms in the eyes of the outside world a unity of which he is the sole representative, so the divinity of the various unseen powers is embodied and shadowed forth to men by the all-embracing heaven, the glorious Father of the Sky. The light of day is

* Cp. Fick, *Wörterb.*, p. 192, and Curtius, *Etym.*, No. 621, with Corssen, *Aussprache, &c.*, ii. 159.

† The former (our own *sooth*) is a derivative from the participle of the root 'to be,' the latter, still more significantly, from the root 'to dwell,' to abide. See Fick, *s. vv.*, and Curt., *Etym.*, No. 208 and 564. The reasons which prevent me from adding with Fick (*Spracheinh.*, p. 277) "to please, *svad*, means originally to taste well" may be seen in Curtius, *Gr. Etym.*, p. 36 *sq.*

‡ Cp. Fick, *Wörterb.*, s. v. *kvanta*.

the favourite emblem of Him who is at other times regarded as the quickening power of the universe and the giver of all its gifts.* It is difficult for us to determine how far the deified natural phenomena, the sun, the moon, the stars, the clouds, the rosy blush of dawn are regarded as the children of the One Supreme, and how far they appear as simple forms of his self manifestation. At any rate language can help us but little, and when we fall back upon the earliest Aryan literature it reveals to us just that condition of flux and vagueness which seems so natural in primitive times, a consciousness of a Divine power manifested in every natural force, which ultimately, by the mythopœic tendencies of languages, passed into a belief in as many individual deities as there were distinguishable features in nature. It is probable that among the first of these to receive an independent existence was the Bride of the Heaven, sometimes taking form as the shadowy night that divides with him the rule of the world, sometimes rather as the mother earth, whom he renders fruitful by his embraces. It would lead too far away from the present subject to examine into the history of the individual deities worshipped in common by the Indo-European nations; it may be sufficient to notice as those of especial interest, Varunas, "the covering heaven," Ahanâ, Saranyû, and Ushas, names for the

* Cp. Fick, *Worterb.*, s. vv. *diaus patar*, *bhaga*, *ansu*. I have met somewhere with the assertion that our English *bogy* can be traced back to the Slav. *bogŭ*, which is identical with *Bhaga*, the "dispenser," a name used especially of one of the great Gods of the Veda. If this be true, the history of language has hardly a more striking instance of the degradation to which a word of noble meaning may eventually come.

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dawn—which passed into Greek, as Ἀθήνη, Ἐρινύς, and Ἕως,—the god of destruction (with apparently varying names connected with the root *mar*),* and Sarameyas, the child of the dawn, the gently-stirring breeze.† A less familiar deity is Parkana, "the rain-god," whose name, apparently lost entirely by the Greeks and Romans, is preserved to us only in Sanskrit and the Lithuanian and Old Prussian dialects.‡ The common Indo-European words for worship and for sacrifice are too vague and general in their meaning to enable us to draw any inference from them with safety; but perhaps it is possible still from the Rigvêda, the Zendavesta, and the poems of Homer to reconstruct some of the favourite liturgical formulas.§

Over against the bright and heavenly company of the children of the Divine power we may see dimly flitting the shadows of treacherous spirits that haunt the

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* See Max Müller, *Lectures*, 2nd Series, c. vii. But the connexion of Ἄρης with Mars is far from being as clear as Mr. Cox (*Aryan Mythol.*, pref. p. 9., &c.) assumes. What other instances are there of the disappearance of an initial *m* in Greek? Nor is it, indeed, certain that *Mars* has anything to do with the root *mar*. "Mars, in the old Italian mythology, was the youthful and beneficent god of plenty, father of the Latin races" (Munro on *Lucret.*, i. 41); and his identification with "the destroying lord of war" is not earlier than the similar identification of the country "god of the homestead" (Hercules) with "the glory of heaven" (Ἡρακλῆς). See, however, Mommsen, i. 175.

† Cp. Mr. Cox's admirable discussion of the word (*Aryan Myth.*, ii. 229-235).

‡ Cp. Grimm, *Geschichte der D. Spr.*, pp. 84-85, and *Deutsche Mythologie*, pp. 156, 160.

§ Fick (*Spracheinh.*, p. 276) compares the Vedic *çravas akshitam* with Homer's κλέος ἄφθιτον, and the Zend *vohu mananh* with his μένος ἠΰ; so ἦρα φέρειν corresponds with *vâram bhar*.

darkness. It may be true, as Professor Max Müller says, that "the Aryan nations had no Devil" * in pre-Christian times, but at least they had many devils, and to them they ascribed a power of bewitching by evil arts.† When these assume a bodily form, it is that of the throttling snake (*aghi*), the emblem and incarnation of the demon of night.‡ But all the gloomier beings come but little into prominence. Our Aryan forefathers, like the gods whom they worshipped, are children of the light, and in it they love to dwell.

But here the curtain falls. When it rises again the scene is changed, and we find ourselves in a different land and time. Hitherto all the Indo-European languages have been pressed into our service and made to contribute the colours with which to paint our picture. But by the side of the group formed thus, there is another hardly less extensive and significant. There are some important characteristics of language and hundreds of individual words that are common to all the European Aryans, but unknown to their Eastern

* *Chips*, ii. 238: but cp. *Lectures* ii., c. x. *ad fin.* (pp. 454-455, 8vo. ed.). Fick, *Worterb.*, p. 272, quotes beside the Skt. *druh* ("fiend of either sex," well described by Max Muller, *l. c.*), the Zend *druj*, the Norse *draugr*, "ghost," the A. Sax. *ge-drôg*, O.H.G. *ka-troc*, ghost or witchery. To connect the word, as Mr. Cox does, with the root of ἀ-τρεκ-ής, is to fly in the face of all phonetic law. See Curtius, *Gr. Et.*, No. 633.

† Cp. Fick, *Worterb.*, p. 37 (s. v. *kartyâ*), and p. 105 (s. v. *dhvar*). With the malicious fairies called in Sanskrit *dhvar-as* he is inclined to connect the German *Zwerge* (dver-ga).

‡ The form under which this spirit commonly appears in Sanskrit mythology, as Vritra, "the hiding thief," does not appear to be Indo-European. Cox, *Ar. Myth.*, i. 342 and ii. 326.

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kinsmen. We can see how the broad, full-mouthed, and somewhat cumbrous, but not wholly inharmonious tongue spoken in the earliest home of our forefathers, has begun to suffer phonetic degradation. Between the open *a* and the feebler *i* we find appearing an intermediate *e*, which cannot have been used by the primitive Aryans.* The vigorous manly *r* has in many cases sunk into the softer *l*.† Forms of inflexion before unknown add greater power of expression to language, and hundreds of new ideas developed or new phenomena noted require that the original stock of roots should be put to wider uses in many ways. All these facts require us to suppose that the forefathers of Aryan nations now inhabiting Europe remained together as a united people after their separation from the Eastern branch.‡ What were the causes then which led to the sundering of the primitive unity? Language of course can tell us nothing of this, and we are in a region far beyond the reach of any historical

* The facts with regard to the European *e* are exhaustively collected by Fick (*Spracheinh.*, pp. 176–200). It is hardly necessary to refer to G. Curtius's masterly paper, *Ueber die Spaltung des A-Lautes*, 1864, or to his *Gr. Etym.*, p. 87.

† Cp. Lottner in *Zeitsch.* vii. 19; Ferrar, *Comparative Grammar*, p. 21; Curtius, pp. 85, 505, and especially Fick, *Spracheinh.*, pp. 201–261.

‡ Various writers have attempted to invalidate the evidence on which this hypothesis rests, and to connect some one or other of the European nations more closely with the Eastern than with the Western Aryans. Joh. Schmidt, for instance (*Die Verwandtschaftsverhältnisse der Indogermanischen Sprachen*, Weimar, 1872), endeavours to show that both the Slavo-Lithuanians and the Greeks are especially nearly related to the Eastern Aryans: but Fick's very careful collections have disproved the theories on which his position is based. Cp. also Curtius, *Gr. Etym.*, p. 24 (E. T.).

record or trustworthy tradition. A possible conjecture is that religious differences sprung up such as those, which have been supposed to have occasioned the further separation of the Persians from the Indians. Perhaps a more probable guess is that an irruption of the wild Turanian hordes split them asunder like a wedge, and that, under the impulse of this invasion, one-half went southwards and westwards to the Persian hills and the plains of Media, or to fight their way for many generations down the valley of the Indus to the wealth of Hindostan, while the other half took a united westward course to the heart of Europe. This is, however, but guesswork. All that language tells us unmistakeably is, that the severance was effected, and that, wherever the earliest home may have been, or however long our ancestors dwelt there together, the time did come when the unity was broken, and the first division appears to have been a bifurcation.* But it does tell more about the condition of the European Aryans. The sea, for instance, was certainly known to them now, though it had not been before,† and we may

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* Albrecht Weber, in his *Indische Skizzen*, has sketched the common life of the Eastern Aryans, and Fick (*Wörterb.*, pp. 225–330) has collected the linguistic materials for adding some touches to the picture.

† Fick (*Spracheinh.*, p. 353), Max Muller, *Lectures*, ii. p. 320. It is perhaps hardly correct for the latter writer to say, "When the Romans saw the Mediterranean, they called it *mare*;" for the occurrence of the word in the Keltic, Slavonic, and Teutonic languages shows that its use was far older, not merely than the name "Romans," but also than any distinct Italian nation. Still less can he be correct in saying (*Chips*, ii., 48) "We find indeed identical names in Greek and Latin, but not in the northern and southern branches of the Aryan family." Cp. Fick, *Wörterb.*, s. v. *maryâ* (p. 384).

see that their knowledge was not merely that arising from vague reports, by the fact that they possessed, not only a common name for fish, but also special names for various sea and shell-fish, among which may be mentioned the seal, the lobster, and the oyster. It may possibly be that even at this early stage of a united life they extended from the Baltic to the Adriatic and the Ægean; but of this we cannot be certain. We are on surer ground when we examine the state of their civilisation. The most important change we find is that agriculture now assumes far greater importance; the terms referring to it, before so scanty and doubtful, occur in profusion; we can determine exactly the words that were used for ploughing, sowing, and reaping, for the cornfield, the furrow, and the harvest, for the seed, the harrow, and the pitchfork. Wheat and barley, oats and millet, all are raised for food; we find, it is true, no common word for bread, but this is easily accounted for: as culture advanced in the sundered nations, new and improved preparations from corn may well have displaced the rude primitive cakes, and with the thing the word may have fallen into oblivion.* Peas and beans, turnips and onions, poppies and hemp, are all grown in the gardens.† No new metals are added to

* The small importance of bread in the early diet of the Romans is shown by Plin. xviii. 8, 19: *Pulte autem, non pane vixisse longo tempore Romanos manifestum quoniam et pulmentaria hodieque dicuntur.* Cp. Becker, *Gallus* iii. 221.

† Dr. Farrar, in his *Families of Speech*, p. 60 (following Pictet, i. 320) lays special stress on the significance of the common European name for flax; but it is more than doubtful whether the

the three which were known to the united Indo-Europeans, but the number of tools that we can prove to have been made from them is greatly increased. Some of these, however, appear to have been still, occasionally at least, made of flints.* Weapons, before unknown, now make their appearance, and defensive armour is seen to be in use. The arts of clothing have developed; weaving, but obscurely hinted at before, and probably not advanced beyond a rough kind of plaiting, is now familiar,† and furs and leather come into prominence as materials of dress. Nor is the advance less conspicuous in the important art of cooking: yeast now first makes its appearance,‡ and various kinds of soup are used.

Every fact that we can gather points us to a life, simple indeed, but settled and orderly, and far removed from barbarism. In religious and moral ideas we cannot now trace any important advance upon an earlier stage, and in fact analogy would lead us rather to look

northern names are not simply borrowed from the Greek or Latin; so that Fick justly relegates the word into the *Wortschatz der Graecoitalischen Spracheinheit* (p. 487). Cp. Corssen, *Aussprache*, vol. i. 533–534. Mommsen (i. 17) notices that even at the present day the Indians only grow flax for the preparation of linseed oil. Whether the vine was known is more than doubtful. Against Mommsen's view (i. 20) see Corssen, *Aussprache*, i. 541–542.

* Cp. Fick, *Wörterb.*, s. vv. *agsiá* "axe," *marta* "hammer," and *skalmá* "knife:" we can hardly dissociate *saxum* from the O. Norse *sax*, A. Sax. *seax*, O. H. G. *sahs*, "knife."

† Mommsen (*Hist.*, i. 17) seems to have fallen into one extreme, as Max Muller (*Chips*, ii. 46) has into the other. But see Fick, *Wörterb.*, p. 180, s. v. *vap*, and *Spracheinh.*, p. 367.

‡ Even Pictet (ii. 310) can find no common Aryan term for leaven, but for the European *bharman* cp. Fick, p. 380: "yeast" seems to be confined to the northern languages.

for incipient confusion and decline. But in political matters the case is otherwise. It is now first that language tells us of other conceptions than those of the king, his subordinate nobles, and the heads of households. The *people* comes into view, and the earliest name by which it is known shows it to us as already the source of all lawful power.* The ideas of *citizenship*† and of *law*‡ appear to us, and we can dimly see the slow developement of that ordered freedom which has, more than any other thing, given to the Aryan peoples their place of pre-eminence in the annals of the world.

But again the curtain falls. Language is silent to our enquiries as to the causes of the new and more complete disruption which followed. Her voice is uncertain and indistinct even when we ask her questions, about which she surely has much still to tell us. We want to know, if not the occasion and the time, then at least the order and the character of the next

* Hardly any common European word is better established than *tautâ*, occurring as it does in two Italian dialects, Old Prussian, Lithuanian, Old Norse, Gothic (*thiuda*), German (in the word Deutsch), and in Erse. For its derivation and connexions, see Corssen, *Aussprachung*, &c., i. 371, or Fick, *Wörterb.*, pp. 81, 365.

† The root of *ḱivis* appears in Sanskrit, cp. Corssen, i. 385, Curt., No. 45, but the formation itself seems purely European: the corresponding Sanskrit form is so different in meaning that it is probably of independent origin. Cp. Fick, *Spracheinh.*, p. 286.

‡ That the Germanic words for law have not been borrowed from Latin has been shown (among others) by Marsh, *English Language*, *Lect.* vi., note. Cp. Fick, *Spracheinh.*, p. 362. It is a curious indication of the changefulness of the Greek institutions that Greek hardly retains a single one of the primitive political terms, not even *ragan*, one of the best established.

migrations; and she mutters in reply words that are hard to interpret. When was it that the Letto-Slavonians left us? How long and how far did the Teutons wander in company before they were severed into Germans and Scandinavians? Did the Keltic peoples break away on their westward journey, with characteristic impatience and desire for change, at an early date? Or did they remain united with the Italian stock till long after the latter had parted from their Hellenic kinsmen? Is it possible to reconstruct from language pictures of the common civilisation of individual groups of nations, such as those which science warrants us in drawing of the united Indo-Europeans, and again of their Eastern and Western sections? And, finally, what were the causes of those dialectic tendencies, which even more than the wear and tear of time, and the desire for greater ease of articulation, broke up by degrees the original unity, and made the Roman seem a barbarian to his Hellenic cousin and the Kelt unintelligible to the Saxon? These and other like questions are pressed upon the oracle of language by eager enquirers, and the answer is not yet read with certainty by any of them. But acute and well-trained patience is working in a hundred quarters with the hope of a full solution, and we cannot fear that its labours will be wholly fruitless. The hand of Time has robbed us ruthlessly of so much of the language of the past, never recorded at all, or long since irretrievably lost to us, that the light is very dim which guides us, and shines with fitful gleams. But I believe that the pictures which I have tried to paint are no phantasmagoria, no shadowy forms of dreams.

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› far as the colours and the outlines have been rnished by sober and legitimate inductions from the :ts of language, they represent knowledge of enduring lue, won for the realm of science from the darkness the vast unknown.

A. S. Wilkins.

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X.

The Talmud.*

Among the nations of antiquity to whom the modern world is indebted for the basis of its civilisation, the Hebrew people occupies confessedly a notable position. One book, nothing more, represents the contribution of the Hebrews to the great bequest made by the past to the present, while the inventory of the treasures inherited from Greece and Rome enumerates an infinite variety of the most beautiful productions of human genius. Still, such is the majesty inherent to that book, that, since its introduction, no attempt on a large scale has ever succeeded in weakening the power of its counsels over the hearts of the countless millions to whom it is a trusty guide on their way from the cradle to beyond the grave. To this book of books the whole of Hebrew literature, covering as it does, the

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* N.B. In this paper	Q q	stands for	Hebr.	ק,	Arab.	ق
	Ḥ ḥ	„	„	ח,	„	ح
	Ḳ ḳ	„			„	خ
	Ṣ ṣ	„	„	צ,	„	ص
The spiritus asper		„	„	ע,	„	ع

For some generally known Eastern words the usual orthography has been retained.

large space of time from the close of the Canon to our own period, forms a grand appendix. Science, ethics, history, fiction in prose and verse, every exercise of the mental faculty, bear, if clad in Hebrew, the stamp of its Biblical origin, a circumstance which necessarily imparts to the character of that literature a feature of one-sidedness, for which, however, the gravity of the diction and the absence of commonplace make no slight compensation. This complex of literary productions is known as the *Rabbinical* or *Traditional* literature of the Jews. Strictly speaking, the *Tradition* is limited to the contents of the Talmud, which, after having been communicated, through generations, by oral instruction exclusively, were ultimately committed to writing, when distressful events placed the teachers between the alternative of preserving their doctrines in written codices and that of exposing them to utter loss. In the wider sense, however, the Tradition includes all ancient Hebrew literary monuments with the sole exception of the Pentateuch, the reproduction of which alone in writing was considered obligatory.

As, in so vast a field, a boundary must be fixed at some convenient point, I deem it sufficient for my purpose to follow the course of the Tradition to about the end of the fifth century after Christ, at which time the Academies in Babylonia were closed by command of the Sassanian kings.

The Hellenistic writings of the Jews of Alexandria, although manifestly dictated by the patriotic desire to inspire the Grecian world with respect for the religion and the ethics of the Jewish people, made hardly any

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impression on the Hebrew-speaking Palestinians. Even the Alexandrian version of the Scriptures was for a season looked upon at Jerusalem as an irreligious attempt sure some day to lead to the substitution of dubious imitations for the one original sacred exemplar. As for Flavius Josephus, but for whom there would not now exist an intelligible post-biblical history of the Jews, his name is sought for in vain among the records of his countrymen; perhaps on account of the base adulation offered by the historian to the destroyer of the sacred temple and city—but was not an equal disregard the lot of the Alexandrian philosopher Philo, the ardent defender of his brethren before the throne of Caligula?

Had the histories of Flavius Josephus been preserved in the Hebrew language (in which some of them at least were originally composed,—see preface to the *Wars*), the interest inherent in the narrative, and the vivacity of the style, would have atoned for the author's political misconduct, and his people would, no doubt, have assigned to him the place due to him in the national library, instead of allowing it to be usurped, a thousand years later, under the name of Josippon, or "Joseph Gorion, the priest," by an uncritical collector of historical facts and legends from Latin, Arabic, and Hebrew sources.

The Hellenistic writings of Alexandrian Jews, while ignored by their co-religionists in Asia, became an active propaganda for the diffusion of Biblical ideas among the Gentiles of Greek nationality; they prepared the soil for the reception of Christian teaching when offered to the heathen world by the first mes-

sengers of the gospel. In return, the Church and the patristic writers (not the Jews) have been the preservers of all the extant relics of Alexandrian Jewish learning.

The apocryphal books of the Old Testament (all of which, with the exception of the First Book of *Maccabees, Judith, Tobit,* and Jesus Sirach, are by the best critics of our day attributed to Jewish writers who lived in Alexandria between 150 before and 100 after Christ) have had a certain rank allowed them by the ancient Church in the Biblical canon. From Alexander Polyhistor and other sources now inaccessible, the Early Fathers, Clemens of Alexandria and Eusebius of Cæsarea, transcribed all that appeared interesting to them in the historical and poetical remains of the Jews of Alexandria unrepresented in Hebrew literature properly so called.

As, on the one hand, the native traditional school of the Jews shut out, so far as ever practicable, all influences not strictly national, so, on the other hand, the subject of its studies was not of a nature to engage the attention of Gentile scholars. The contents of the Hebrew Bible *had* become attainable, since the second century before Christ, to every enquirer familiar with Greek—that is, to every educated person in the Roman Empire. This was especially the case when, in the first Christian age ("primis fidei temporibus"), as St. Augustine states, innumerable Latin versions appeared. But the Jewish Tradition and its dialectics remained a mystery of which a select body out of a small population held the key; and thus it has really been ever since, with rare exceptions.

It would, however, be a grave historical error to deny to the Traditional school of the Jews a deep effect on the philosophy and the ethics of the world, far beyond the narrow precincts of the synagogue. What more powerful, more lasting, than the effect wrought on the thoughts and feelings of men, generation after generation, by the argumentative writings of the Apostle Paul, a most diligent student, according to the strictest system of the Tradition, under Rabbi Gamaliel the Elder, who was the grandson of the illustrious Hillel, and at that time president of the Synedrion of Jerusalem? The close conformity of the Apostle's dialectics to those of the Doctors of the Tradition is fully brought out in the 'Rabbinical Commentary' on some of the Pauline epistles published in Hebrew by a great German Talmudist. (Cp. Tholuck, *Verm. Schr.*, B. ii. p. 284.) Thus, at the commencement of the world's new era, the Traditional method of the Jewish schools achieved a triumph second to none in the history of the education of mankind.

Synchronistic convenience might tempt me here to name Philo-Judæus of Alexandria, who became the head of a philosophical school of high renown among metaphysicians; but Philo, though full of zeal for the law of his fathers, betrays little, if any, acquaintance with the doctrines and principles of the Tradition, and whatever influence he may have acquired, cannot, in fairness, be set down to *its* account.

The astounding revolution produced in the moral, and gradually in the political, world nearly 2,000 years since, by the spread of Pauline Christianity, had its parallel, although on a less extensive area, in the age

of the Reformation. When the Reformation had become an accomplished fact, with the overthrow of Spanish political supremacy, the emancipation of the European mind from mediaeval tutelage proceeded rapidly. The bonds were loosened which had until then held science attached to doctrinal theology. A new basis was laid for the study of experimental science, and speculative philosophy strove to discover a new and superior *method*. Eight years after the death of Bacon, Benedict Spinoza was born at Amsterdam, in 1632, from whom proceeded that mighty impulse which has carried the philosophy of Germany to the height reached by it in our days. Now, that man was a paragon of Talmudical learning, the favourite pupil of Rabbi Morteira, of Amsterdam, before ever he *commenced* the study of Latin grammar under good Dr Van Ende, and it is therefore only fair to attribute to the intellectual discipline of the Talmud the largest share in the preparation of his mind for his vast achievements as a philosopher. He was misunderstood, he was ill-treated, by his contemporaries, but full amends have been made to his memory by a more enlightened generation. "A brave and simple man, earnestly meditating on the deepest subjects that can occupy the human race," says an English biographer of Spinoza, in 1846, "he produced a system which will ever remain as one of the most astounding efforts of abstract speculation—a system that has been decried for nearly two centuries as the most iniquitous and blasphemous of human invention, and which has now, within the last sixty years, become the acknowledged parent of a whole nation's philosophy, ranking

among its admirers some of the most pious and illustrious intellects of the age."*

Thus, the apostle of the first, and the philosopher of the seventeenth, century, however really or apparently antagonistic on dogmatic points, concur in furnishing strong personal evidence of the effect of the Talmudical system upon the onward movement of mankind.

The theology of the Jews has passed through the various phases of every positive religion founded on a revelation. The revealed rule of faith and conduct rendered an interpretation necessary as soon as its principles came to be practically applied. Beliefs and practices not provided for in the sacred books seemed to deserve admission for the advancement of the religious sentiment; beliefs and practices, on the contrary, though sanctioned by the express terms of the fundamental law, were found no longer to harmonise with the requirements of the age. It became a manifest necessity to seek somewhere for authority to amend, to add, or to abrogate, without at the same time detracting from the reverence paid to the repository of the revelation. Naturally the leaders of the people—the elders, the priests, or under whatever title the sacred trust was held—supplied the needed authoritative interpretation of the written word, taking care to preserve the spirit of the faith in its vitality; and the Tradition became a recognised fact. Henceforth orthodoxy meant a belief in the Revelation as interpreted by the Tradition. Orthodoxy, under whatever name it existed, could never seriously repudiate this connexion;

* G. H. Lewes, *Biogr. Hist. of Phil.*

at best, a compromise might be made between unconditional submission to Tradition and the assertion of the individual believer's freedom of conscience. If, however, the Tradition is altogether rejected, while the belief in the sacred Word is maintained, mysticism is produced,—that is, the believer dives into his inner consciousness, there to discover that indispensable interpretation of the revealed Scripture which he is unwilling to accept at the hands of an established living authority. Historically these various conditions of the religious state may co-exist in different proportions of prominence. An illustration of the developement just described is furnished, for instance, by the history of Mohammedanism. Soon after the compilation of the chapters of the Quran the collection of the Traditions was commenced, which under the title of Sunna (and Ḥadith), professed to give an account of the sayings and doings of the Prophet. Orthodox Mohammedanism concedes to both the channels of revelation an equally profound veneration. For the Prophet said, through the mouth of 'Ali Ettabarani (Hammer, *Encycl.*, p. 635): "I have bequeathed to you two things; while you hold fast by them, you cannot possibly fall into error, viz., the Scripture of Allah and my Sunna, *i.e.*, my sayings and doings. Both will remain with you until the day of judgment" Orthodoxy did not long remain in quiet possession of the field. On many points considered vital, the Tradition was questioned by the معتزلة "seceders" (from عزل to separate) and other sectarians, who were but the forerunners of the Sheans شيعة, politico-dogmatical heretics, who have been for many centuries

dominant in Persia, and are more fiercely hated by the Sunnites or Traditionalists, whose chief is the Ottoman emperor, than any of all the seventy-two heresies known to the Canon-law of Islam. Muradgea d'Ohsson, the learned Armenian (in his *Tableau of the Ottoman Empire*, p. 82), states that, whenever the Turkish troops took the field against the Persians, the Mufti (or religious chief of Constantinople) issued a proclamation (fethwa) to the army containing the assurance "that the destruction of one Shean was more pleasing in the sight of Allah than the slaughter of seventy Christians or other unbelievers." Now Persia, more than any other Mohammedan country, gave birth to mysticism under various titles, the most renowned of which is Sufism (from صوف wool, on account of the cloak of that material worn by the adepts). Some of the most celebrated among the Persian poets adorned the mystic doctrines of the Sufi with the charms of their genius. "The mysticism or spiritualism of the East, known by the name of Sufism," says M. Tarcin de Tassy, a high authority on these questions (*Les Oiseaux et les Fleurs*, p. 13), "is styled by the Arabs of the sect, 'the knowledge of God.' It acknowledges different grades of initiation, but it is sufficient to know, that the Sufi in general aspires to enjoy a perfect state of supernatural and ecstatic intuition; the system not only rises above the positive precepts of religion, it leads to a state of indifference on the question of faith or infidelity, and to a forgetfulness of the world present and future." "The very essence of Sufism is poetry," says Sir John Malcolm, the historian of Persia (ii. p. 308). "The Musnavi of Jellaludeen,

the works of Jâmi, the book of moral lessons of the eloquent Sadi, and the mystic odes of Hafiz may be termed the Scriptures of the Sufis of Persia. It is to them that they continually refer, and the gravest writers who have defended their doctrine, take their proofs from the pages of these and other poets, whom they deem to have been inspired by their holy theme."

The Jewish Church has passed through revolutions analogous to those noticed in the history of Islam, although enacted on a less conspicuous stage, and therefore less known to the world in general. Every denomination of Israelites that has ever existed has professed allegiance to the laws of the Pentateuch interpreted *traditionally*. The Karaite Jews, coetaneous with the rise of Mohammedanism, and still extant in Egypt, in the Crimea, and in some localities of the former kingdom of Poland, have not discarded the aid of *a* traditional interpretation of the Mosaic law, notwithstanding the title adopted by the sect (from קרא, to read, בני מקרא, Scripturalists.) (See J. C. Wolf, *Notitia Karæorum ex Mard.*, &c., p. 69, note *: "Non omni destituuntur traditione Karaei, quam majoribus suis acceptam ferunt.")

After the return from the Captivity the Jews devoted themselves to the study and practice of the Law with a zeal previously unknown, and kept it alive long after the commonwealth itself was overthrown, in the second century after Christ. Without entering into the political history of those centuries, in the course of which the diminutive Hebrew State defended itself triumphantly against the trained armies of Alexander's successors and resisted the legions

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of Republican and of Imperial Rome with a bravery unsurpassed by the most warlike races of antiquity, I must content myself with a brief survey of the *religious* movement among the Jews in that period as it is represented in the books of the Tradition. The traditional data assume a historical character about the epoch of the Maccabees or Hasmoneans, in the earlier part of the second century before Christ; the region beyond that boundary affords no secure footing. It is true that the Annalists exhibit a chain of Traditional teachers from the closing of the Talmud with Rabina, in 498 after Christ, up to Moses the son of Amram, as may be seen in the introductory dissertation on the Mishna by the great Maimonides of Cordova, in the twelfth century. The Mishna itself devotes a whole treatise, Aboth, to an account of the fathers of the Tradition, which begins with this declaration:—"Moses received the Law from the height of Sinai, and delivered it to Joshua, and Joshua did to the elders, and the elders to the prophets, and the prophets delivered it to the men of the Great Synod." This "Great Synod" was the administrative body established after the return from the Captivity, and it remained in power for the space of about two hundred years, to the time of Alexander the Great, when the Holy Land fell under the rule of Grecian sovereigns. But when we consider that the Mishna records only three sayings, in one single sentence, viz., "Be slow in passing judgment—establish many disciples—make a preventive fence around the Law" (*Aboth*, i.)—of this Synod, to which the Tradition attributes 120 members from first to last during

the 200 years of its official existence; when we consider that only one name appears in an interval of 170 years between Shim'on the Just, the last representative of the Synod, and, according to the Talmud (but not according to Josephus), a contemporary of Alexander of Macedon, on the one hand, and Jose the son of Joezer, who fell in the Maccabean War (Frankel, ד״מ, ל׳) about 160 before Christ, on the other hand—we are driven to the conclusion that many links must be wanting in the chain, and that we have here vague data, useful as landmarks, but lacking that continuity which warrants historical confidence.

Although out of the vast number of Talmudical sayings and maxims only three are set down to the men of "the Great Synod," their activity exerted, nevertheless, a great influence on subsequent generations. For, besides composing prayers, which are at this day the basis of worship at all synagogues, they collected and classified the Sacred Scriptures, whence, on account of the scrupulous care bestowed by them on *the book* (ספר) of the Law, they were emphatically styled Scribes (סופרים), from Ezra (vii. 7), "the ready Scribe in the Law of Moses," to the close of that period in the Maccabean age. It is a significant fact that the Apocrypha, which breathe a spirit of ardent patriotism, as in the books of *Maccabees*, or of a high morality, as in the books of *Sirach* and *Ecclesiasticus*, and all of which redound to the honour of the national name, were, nevertheless, rigidly excluded from the Canon. The "Great Synod" was succeeded by the Sanhedrin, *i.e.*, *συνέδριον*, the Council, presided over by duumvirs. The Tradition calls them *pairs* (זוגות).

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one of whom was styled "prince," נשיא , and the other *Chief of the Court*, אב בית דין, (ר"ה, י'ב, ט'ו). At the time of the restoration under Jeshua the priest and Zerubbabel (*Ezra* iii. 2), in the year 536 B.C., the high priest of the day was the recognised political head of the nation, and this state of things continued until the pontificate became the prey of the usurper Jason and of his brother and rival, Onias (in Greek, Menelaos), at the beginning of the Syrian troubles, in the first half of the second century before Christ. The people then lost confidence in the high priest, who, indeed, retained his political position; but the religious leadership and the judicial authority were entrusted to the great Council, under a president, "Nasi," and his coadjutor, the "Chief of the Court." These continued to exercise legislative and judicial authority under the Hasmonean and the Herodian dynasties, until every semblance of jurisdiction was reduced to a mere shadow and a name by the high-handed rule of the Roman governors. The dignity of "Chief of the Court" ceased with Shammai, the colleague of Hillel, in the time of Herod; but the title of "prince" survived the fall of Jerusalem, and remained in the family of Hillel, a descendant of King David, for four hundred years. Some confusion has been caused in the chronology of Hillel's successors by the frequent recurrence of the same four names, viz., Hillel, Simeon, Gamaliel, and Judah, in the space of these four centuries.

The war of liberation waged by the five sons of Matathias Ḥasmon, the priest of Modeïn, against the Syrian kings, from 167–130 B.C., forms one of the most thrilling episodes in the sad epic of Jewish history.

The attempt to force upon the Israelites the idolatrous worship of the Greeks roused a spirit against Grecian ideas in general, strong enough to endure for many ages, and even to continue in vigour among the early Christians of Jewish blood. Before the Captivity it had been the constant and difficult task of the patriotic prophets to ward off from their countrymen the frequent encroachments of the cruel and impure polytheism of Palestinian and Syrian heathens upon the worship of the One God. After the restoration under Cyrus, not a trace of the former proneness to polytheism remained perceptible. The contact with the Zoroastrians may rather have contributed to confirm the Hebrews in the pure monotheism upheld by their own prophets. The followers of Zoroaster adored no images, did not even pray in temples, they paid a strict regard to the distinctions between pure and impure and to the superior sanctity of the priesthood. Indeed, by contrast with other Asiatics, the Persians seem to have been regarded by the Hebrews, and probably also the latter by the former, as not very far removed from the truth.

Perhaps, on account of this degree of affinity, the persecutions which the Jews *have* suffered from the Zoroastrian rulers of Persia have at no time been so virulent or so protracted as the tribulations laid upon them by the idol-worshippers of Greece and Rome. There is no doubt that the Jewish exiles adopted many a religious idea and practice from the Iranian fire-worshippers. The Rabbins admit, without disapproval, that the names of the angels are of Babylonian origin. Indeed, there is a mass of evidence to prove that the

conceptions of the angelical hierarchy, of the existence and the activity of good and evil spirits, of the resurrection of the dead on judgment-day, as these ideas are developed and systematised in the Talmud and other Jewish books of that epoch, bore a striking resemblance to articles of faith recognised in the religion of Zoroaster. Of course, on closer examination, the essential differences between Judaism and Parsism are considerably greater than all the formal coincidences that present themselves at first sight.

Altogether different were the relations between Judaism and Hellenism when they were brought face to face. The austerity of Jewish manners was an object of raillery to the vivacious Greek, proud of his artistic and philosophical superiority; the frivolity, the dissoluteness of Grecian life, excited a decided repugnance in the mind of the morally better trained Jewish beholder, who was probably debarred from an insight into the *redeeming* qualities of Grecian culture. Thus, of all the philosophies taught in Greek schools, the Jews of those ages mention none but the system of Epicurus, and that only after the popular notion of it, agreeably to which the Epicurean was a man who devoted his whole existence to the pursuit of worldly enjoyments. In the Rabbinical books Epicurus has become a representative man—another term for infidel, or even atheist. The political supremacy of Alexander's successors in Egypt and Syria was borne, on the whole, supinely, as the rule of the Persian had been theretofore; but when Apelles, in the name of his Syrian master, summoned the inhabitants of Modeïn to set up images for worship

(Joseph. *Ant.* xii. 6), a burst of indignation was the response, and a terrible war of nearly twenty-five years' duration ensued, which terminated in the elevation of Shim'on (or Simon), one of the sons of the Hasmonean Matathias, to the rank of governor, leader of Judæa, and high priest (1 *Macc.* xiii. 42), in the year 140 B.C., followed up some ten years later by the final declaration of the national independence by his son and successor Hyrcan. The effects of the religious fervour that led the Maccabees to victory were not an unmixed benefit to the country. One effect was the importance now, more than ever before, given to differences of opinion on dogmatic and ritual points of the law—differences which had, no doubt, an inchoate existence in antecedent ages, but had never, as now, been fought *for* and *against* with the weapons and the ardour of theological warfare. Under the Maccabees it was that the nation was divided into two very unequal sections—the Pharisees and the Sadducees. A copious literature has been accumulated on the origin and essential criteria of these sectarians; but until recently nothing more was to be obtained from the numerous dissertations and theses on the subject than a re-statement of data uncritically culled from Josephus and his copyists, and enlarged with imperfectly interpreted extracts from Talmudical authorities.

A re-investigation of the question, on independent grounds, by such men as Geiger, Jost, Grätz, has led to a settlement which is rapidly receiving the sanction of the most competent scholars. The result of Dr. Geiger's studies, from which it will henceforth be unadvisable materially to swerve, may be summed up

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thus:—At the moment of regaining the land of their fathers, the Jews recognised Zerubbabel (of the line of David) and Jeshua (or Joshua, the high-priest, of the family of Zadok or Ṣadoq) (*Ezra* iii. 2; 1 *Kings* ii. 35), as their legitimate chiefs. The descendants of David soon lost their power; within a few generations after Zerubbabel they disappear from public view (1 *Chron.* iii. 19). Not so the pontifical family of Zadok, whose last representatives, however—Jason and Menelaus—provoked the discontent of the people by their pride and their too manifest inclination to form alliances with the princes of neighbouring States. When the Maccabees assumed the insignia of both King and High-priest, the priestly families of the old *régime* and of the new formed an aristocracy which stood on the privileges of its caste, laying the greatest stress on the sanctity of the priestly *person*, on whom, these men protested, higher and more onerous duties were imposed by the Mosaic law than on the laity. They felt and acted in the spirit of the Zadokites of old, and the people continued to call them by the same name (Sadducees); while, among themselves, they preferred the title of "children of the priests." These pretensions were certainly not weakened by the investiture of Shimʿon Boëthus, father-in-law to King Herod, with the dignity of high-priest. A large share of the executive, and the whole of the diplomatic, power fell into the hands of that priestly court-party, the close intimacy between which and the Sadducees appears, *e.g.*, from such statements as these in the *Acts of the Apostles* (iv. 1): "And as they spoke unto the people, the priests and the captain of the temple and the Sadducees came

upon them;" or (v. 17), "Then the high-priest rose up and all they that were with him, which is the sect of the Sadducees," while the national council or Synedrion of the day was under the presidency of Gamaliel, a layman, of the family of Hillel. Against this hierarchical nobility there stood and worked the democratic multitude—the *national party*, headed by the learned in the Law, the men who derived *their* positions from their personal merit, and many of whom belonged to the poorest of the poor. A Talmudical sentence will illustrate their position: "This is the path," say they (*Aboth*, vi. 4, &c.), "to be pursued in the study of the law: thou shalt eat bread and salt, shalt drink a cup of water, sleep on the bare ground, shalt live a life of privations, but shalt labour for the study of the law: if thou do so, thou wilt be happy, and it shall be well with thee: thou wilt be happy in this world, and it shall be well with thee in the world to come. Do not look for personal grandeur, do not covet badges of honour; practise more than thou teachest, and have no desire to sit at the table of princes; for truly thy table is more glorious than theirs, and thy crown more brilliant than theirs—the study of the law is higher than the *priesthood;* it is more exalted than royalty!" Of this stamp were the much decried Pharisees, whose prototype is found, as far back as in the days of Ezra and Nehemiah, in the men "who separated themselves from the people of the land unto the law of God" (Neh. x. 28); that is, who kept aloof from alliances with the idol-worshippers of Palestine. They were called "the separated," נבדלים, of which Pharisees, פרושים, "abstainers," is the Aramaic rendering. This

"party of the people" denied the exclusive sanctity of the priestly *person*, admitting, however, the sanctity of the priest's *functions*; they emphasised the Biblical declaration "that the whole nation was a kingdom of priests, and called holy" (*Exod.* xix. 6), and to justify this lofty claim of equality they voluntarily prescribed to themselves "abstentions" of a ritual or sacerdotal character. This was especially the direction taken by the people called Essenes in Josephus and some patristic writings, but nowhere mentioned by name in the New Testament or the Talmud. They did *not* form a distinct sect, and only distinguished themselves from the rest of the Pharisees by the strictness and austerity of their religious practice. They are alluded to with high praise in the Talmud and the books of the *Maccabees* (I. vii. 13; II. xiv. 6); in the latter as the pious ἀσιδαῖοι, an imitation of the Hebrew חסידים of the Talmud. Towards the end of the Hasmonean period they re-appear, covered with a nimbus of mysticism, addicted to soothsaying, and making much of ablutions and other external tokens of purity. They may be the same as the Hemerobaptists cited by Eusebius (*Eccl. Hist.*, iv. 22) among the Jewish sects (this term need not be interpreted strictly), and if so they are identical with the Morning-baptists טובלי שחרית, mentioned in the Talmud as rigorists, who considered daily early baptisms a religious duty. This being admitted, the etymology of Ἐσσηνοι or Ἐσσαιοι, in Josephus and others, as proposed by Grätz, from the Aramaic סחא, to bathe, seems less forced than any of the thirteen or fourteen derivations hitherto suggested.

The Pharisees survived the Sadducees, whose royal state was confiscated by the victorious foreigner, and whose pontificate ended with the cessation of the Temple service. Political antipathies were thus set at rest; but the points at issue between the great majority, viz., the Pharisees, and the evanescent Sadducee minority, on dogma and ritual, were raised ever and anon, with more or less vehemence, throughout the Talmudical period; and they gained a renewed importance in the seventh century after Christ by the appearance in Babylonia of the anti-Rabbinical Karaite sect, still existing, which their Rabbinical adversaries until lately persisted in describing, on insufficient grounds however, as a mere facsimile of Sadduceeism. What those differences amounted to must, in the absence of a Sadducee literature, be collected from the sparse data furnished by their opponents. Disputes on ritual observances, purifications, &c., hardly deserve enumeration; but the two sects were also at variance on some parts of the law of succession and of divorce, and of the criminal code; as, *e.g.*, on the application of the *lex talionis*, which the Sadducees interpreted literally—"an eye for an eye, and a tooth for a tooth;" while the Pharisees, with a better show of reason, maintained that the ancient Law contemplated the payment of a *compensation* for the personal injury inflicted. The principal cause of contentions, apart from political rivalry, lay in the province of dogmas. The Sadducees did not reject the Tradition as a whole: they negatived *some* of the traditions held by the Pharisees, but to many they assented. They rejected the belief of the Pharisees in

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the resurrection of the body (*Mark* xii. 18), which is not identical with a denial of the immortality of the soul, although the two doctrines are too frequently confounded. We are informed that they denied the existence of angels (*Acts* xxiii. 8); but this admits of a modification: unless the Sadducees rejected the authority of the Scriptures—which they manifestly did *not*—how could they explain away the *existence* of angels, so frequently introduced in the sacred texts? It may, therefore, be assumed that what the Sadducees really disallowed was the *influence* of angels and of spirits, good or evil, on the affairs of this world—on which the Pharisees held a complete and far-reaching theory, similar in many respects to that of the Zoroastrians with regard to the celestial "Amshaspands," the protecting "fervers," and the destructive "devs." There were also controversies between the two parties on the extent of divine providence, and on the freedom of the human will, on all which, the views entertained by the Pharisees, in contradistinction from those of the Sadducees, would now be pronounced the more sound and enlightened. In fine, the Sadducees were anything but free-thinking libertines. They sprang from the sacerdotal families at the head of the emigration from Babylon. They were the descendants of the Zaddokites in power before the era of the Maccabees, and they were strengthened by all who, on some ground or other, took their rank among the aristocracy of the country, especially by the accession of the clan of Boëthus, raised to the high priesthood in the time of King Herod (Geiger, *Urschr.*, p. 149). They occupied high places in the administration of political

and judicial affairs. They formed the conservative party, content with the privileged position made for the priests under the Mosaic law, and adverse to the principles of fraternity and equality. The Pharisees were the national party, the religiously-minded *commonalty*, favourable to the adoption of such reforms as, according to their light, tended to make the laws of the Pentateuch harmonise with the altered conditions of their time. They were *not*, all current notions notwithstanding, one and all of them, sanctimonious hypocrites. The testimony of Josephus (*Antiq.*, xviii. 3) to their high standing on account of "their entirely virtuous conduct, both in the actions of their lives, and their discourses also," may be allowed to go for nothing; but the well-authenticated lives of so many of them, who did not recoil from making any sacrifice, even to martyrdom, for conscience sake, convincingly refute the wholesale accusation. There have been, no doubt, insincere intriguing subjects among them. Was there ever a class of men exempt from such alloy? but the sweeping charge is anything but just. Far too much has been forced from a passage in the Talmud (*Sotah*, 22, *b*) which speaks of seven sets (not *sects*) of Pharisees, only two of which, viz., the Pharisees from *love of God*, and the Pharisees from *fear of God*, are looked upon as worthy of the name. What does it amount to? There *never* existed *externally* such a division among the Pharisees at all. That there is satire in the Talmudical reproof is obvious. The meaning of it is simply, "*il y a fagots et fagots*"—"there are Pharisees and Pharisees"—more of the doubtful sort than of the genuine, in strict conformity with the composition of

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societies everywhere. On the very same page the Talmud interprets its own words, quoting the advice given by King Jannæus to his wife Alexandra—"Fear not the Pharisees, fear not their opponents; but beware of those painted individuals who call themselves Pharisees, but are not."

Till lately the notion generally entertained of the origin and character of the Sadducees was that taken from the *Aboth* of Rabbi Nathan, a commentary in forty-one chapters on the Mishnic treatise *Aboth.* Commenting on the words of Antigonus of Socho, in the third section of the first chapter, "Be not like servants who serve their master for the sake of their wages, but be like servants who serve without thinking of their pay, and be ye actuated by the fear of Heaven," Rabbi Nathan states (chap. v.) that Antigonus had two disciples who propagated his doctrine, which was misunderstood in the course of time and gave rise to the heretical opinions of the Sadducees and Boëthusans. On so slender a foundation was raised the history of the two heresiarchs Ṣadoq and Boëthus transformed into disciples of Antigonus of Socho, without any surer warrant for the supposition than the loose statement of Rabbi Nathan, whose commentary, moreover, in its present form, is set down by Zunz (*Gottesd. Vortr.*, p. 109) to an anonymous writer of the post-Talmudic age (comp. Geiger, *Zeitschr.*, 1863, p. 39).

From Babylon Ezra re-introduced the law of Moses into the Holy Land; 500 years later, Hillel the Elder migrated from Babylon to Jerusalem (in the year 32 B.C.), was appointed Nasi, Prince, *i.e.*, president of the Ṣynedrion, and in that capacity gave a fresh impulse

to the study of the law on Traditional principles. From that time the line of teachers, both in Palestine and Babylonia, is drawn continuously and with satisfactory historical accuracy down to the close of the schools in the metropolis and the colony. Neither the emigration under Zerubbabel nor that under Ezra or Nehemiah, disturbed permanently the Hebrew settlements in the Persian dominions. The Talmud insists on the fact that the most notable families did not abandon their dwelling-places between the Euphrates and Tigris. The Hebrews in Persia lived in compact communities, according to their own customs and mainly under their own laws, watched over by the "prince of the captivity" (ריש גלותא) of the line of King David. Palestine was indeed looked upon as the centre of authority to which a degree of allegiance was conceded by the whole race, sections of which were very early, and particularly after the era of Alexander, settled in numerous places of Western Asia and North Africa, and afterwards about the time of Augustus in several provinces of Greece proper and Italy. Alexandria, for some centuries after its Macedonian founder the emporium of the world and the Athens of the age, contained a large Jewish population, which occupied the Delta, and another of the five divisions of the city; these strangers threw themselves with energy into the intellectual movement encouraged by the Ptolemies; they were famous artisans, and rose to importance through the extent of their commerce, a pursuit scarcely known among them in the Holy Land, but for which they seem to have acquired great skill and an imperishable taste in their rivalry with the Greeks of

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Alexandria. The Alexandrian synagogue, a grand building in the form of a basilica with a double colonnade, became in after times the theme of many a popular legend illustrative of its magnitude and splendour. Egypt possessed, moreover, from about 160 B.C. until 73 A.C. (233 years) a temple, a miniature copy of that at Jerusalem, and the only one that ever existed beyond the boundaries of the Holy Land. It was built and inaugurated by Onias, the last remnant of the priestly family of Joshua, the companion of Zerubbabel. Onias fled into Egypt to escape from the intrigues of Jason and Menelaus, the rival usurpers of the high-priesthood, in the beginning of the reign of Antiochus Epiphanes. He was kindly received by Ptolemy Philometor, and for some particular services rendered, the king granted Onias leave to dedicate, on the site of a former heathen altar, a temple to Jehovah, in the district of Heliopolis, some twenty miles from Memphis, within the land of Goshen, to the high gratification of the Egyptian Jews, who saw therein the fulfilment of a prophecy in Jesaia (xix. 19): "In that day there shall be an altar to the Lord in the midst of the land of Egypt."

In Jerusalem the existence of the temple of Onias was not considered to betoken a schism, inasmuch as the Egyptians themselves conceded to the temple at Zion its metropolitan supremacy, and in every other way maintained friendly intercourse with the brethren at Jerusalem. The Alexandrians did not, however, contribute in an appreciable degree to the developement of the study of the Law, and there is, indeed no mention in Jewish literature either of their schools or of repre-

sentative teachers produced by them until long after the Talmudical epoch.* Babylonia, on the contrary, was studded with schools and synagogues, some of which date from the time of Ezra, and even of Ezechiel, if the local traditions may be trusted. Long before the destruction of the second temple there were seats of learning in the valley of the Euphrates, at Nehardea, Sura, Pumbeditha, and elsewhere; but the history of these academies and their leaders is sadly defective prior to the first century before Christ. Learned men and youths desirous of learning frequently passed between Babylonia and Palestine, whereby the unity of doctrine was maintained. Thus Hillel in his youth went to Jerusalem to study there, then returned to the country of his birth, till in the year 32 B.C., at the age of forty-three, he was called to occupy the presidential chair in the great Sanhedrim. With him a new era begins. Hillel is the moral hero of the Tradition. He exhibited those qualities which form the ideal Hebrew character: great gentleness, deep humility, and perfect equanimity under all trials—the product of the love and fear of God. The deterring austerity of his otherwise estimable colleague, Shammai, is used as a foil to set off Hillel's superior amiability. Numerous sayings of a high moral beauty are attributed to Hillel. He it was that said *Aboth*, 1, 12): "Love peace and pursue it; love all men, and *thus* bring them near to the law of God." To the heathen who wished to be made acquainted with the whole law in *one* lesson, he said (*Sabb.*, 31):

* Iohanan Hasandelar was a native of Alexandria, but he studied in the Holy Land, under 'Aqiba.

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"Do not to thy fellow-man what thou wouldst not that he should do unto thee; this is the *whole* law, all the rest is commentary.* He also said (*Aboth*, 1, 13): "The man that hunts after fame shall lose his good name; he that does not progress in knowledge goes backward; he that does not care for knowledge commits suicide" (literally, deserves death); "but the man that uses learning for self-glorification deserves to be forgotten." He passed legal reforms, especially in the direction of the transfer of landed property, which were demanded by the change through which the people had passed from an agricultural life to the more varied pursuits introduced into and fostered by a livelier intercourse with foreign countries. But the memory of Hillel is chiefly revered for his greatness as a teacher of the Law. He collected the numerous oral traditions handed down from generation to generation by the learned; he arranged them into six well-defined orders, according to their subjects; he drew up seven hermeneutical canons, afterwards expanded into thirteen, and even thirty-two (Zunz, p. 32), for the legitimate interpretation of the sacred written text; in fact, he prepared the materials which one of his lineal descendants used, some 200 years later, for the compilation of the Mishna.

The literary productions of Hillel are lost; all that

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* This maxim does not belong to Hillel by right of priority, but by that of adoption. The very words are found in the much earlier apocryphal book of *Tobit* (iv. 16). The same sentiment is expressed in the Chinese Shoo-King by centuries anterior to Hillel (Part iii. ch. 2, Pauthier's Edit.), and in the Gospels (Matt. vii. 12, Luke vi. 31).

is known of him, his sayings and doings, is contained in the volumes of the Talmud. The disparity of character which distinguished Hillel from his colleague was intensified in their respective disciples. Two schools (not sects) were formed by them, and for the space of 110 years the controversies between "the house of Hillel" and "the house of Shammai" swayed the Synedrion, sometimes towards a more rigid, but generally towards a more lenient, interpretation of the law. Still, such was the respect which *both* commanded, that their contemporaries acknowledged the words of both schools to be the expression of unbiassed truthfulness. Soon after the death of Hillel and Shammai, the Romans laid their heavy hand on Judæa, and their imperious authority speedily absorbed all independent national life. Some twenty years after Hillel, the power of judging criminal cases was withdrawn from the Synedrion, which lost its character of a high court of justice, and of its own accord abolished the now useless dignity of Abbethdin (president of the tribunal), which had hitherto existed side by side with that of Nasi (prince). The only distinction that abode with the Synedrion was its possession of the highest authority in the country as a *school of law.* Just before the surrender of Jerusalem it was found necessary to remove the Synedrion from its place in one of the halls of the Temple to the town of Iamnia or Iabne, at some little distance from the sea-coast, the requisite safe conduct having been obtained from Vespasian.

It is related (*Bab. Gittin,* 56) that Rabbi Iohanan Zaccai, last of Hillel's scholars, enjoyed the favour of the Roman general, who, on that account, promised to

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grant any request the Rabbi might make. Iohanan then petitioned, first, for the safety of his chief, Gamaliel the prince, and next for permission to keep open his school at Iabne. Having obtained these grants, he returned much cheered to his disciples, feeling convinced that the power of the schools would eventually prove of greater effect for preserving, than the power of the legions for destroying, the institutions of the Israelite people,—and he judged aright.

The fall of Jerusalem decided the fate of the nation. The intrepidity which the overmatched people opposed to the military superiority of the Roman aggressor was visited upon them by Titus, when the fortune of war turned in his favour, with a vindictiveness little in accordance with the title of "Delight of the World" (*deliciæ mundi*), bestowed upon him at a later time. In the books of the Jews he figures under no other name than that of Titus the Wicked (טיטוס הרשע). The fiscal extortions of the Romans, the persecutions decreed under Domitian, who aimed at the destruction of every remnant of the royal family of David, as politically dangerous, goaded the Jews, within short intervals of time, into three formidable but fruitless insurrections, from Babylonia to the African Syrtis, against Trajan and Hadrian. The desperate struggle under the leadership of Bar Cocba or Bar Coziba, supported by the whole Jewish population of Palestine and beyond it, was the dying effort of the *only* nation that durst, as Tacitus tells us, provoke the anger of Rome by refusing to submit (*Hist.*, v. 10). That the Jewish people survived that war which culminated in the carnage at Bether (on the 9th of Ab, 135) is one of the

marvels of history. According to Dio Cassius (lxix. 13) 580,000 were put to the sword by the Romans, exasperated at their own losses. The captives were sold in the Roman slave-markets at the price of beasts of burden. The most illustrious men of the country suffered death, as rebels, say the Romans—as sainted martyrs in the opinion of their countrymen, among them Rabbi 'Aqiba, a distinguished teacher who left the hall of the school to become shield-bearer to Bar Cocba when the latter unfurled the banner of the holy war. The darkness which overhung the present did not extinguish the hope of a glorious future. The faith of Israel in his destinies could not be shaken by the events of the passing hour. "The law was yet to come out of Zion to the whole world, and the Word of God from Jerusalem." But the depositaries of the law were dispersed; the study of the law had no secure, no fixed, abode in the land. *Ten* times did the Synedrion migrate from city to city (*Rosh Hash.*, 31) after its involuntary removal from the free-stone hall (גזית) in the Temple. The anxious consideration of the impending dangers induced the patriarch Judah, among whose ancestors were Hillel and Gamaliel, to collect and to classify, about the end of the second century A.C. in the town of Sepphoris, all the traditions handed down to his time, and thus to enable the teachers who were, however, to be solemnly ordained in the patriarch's court, to diffuse the doctrine uniformly throughout the countries of the dispersion. By this means the bond of religious and national unity was to be preserved, despite political adversities, and, indeed, the experience of nearly seventeen centuries has justi-

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fied that far-sighted hope. Thus was formed the *Mishna* or "diligent teaching" (from שנן), into which the author received whatever collectanea of the same character several of his predecessors, from Hillel the Elder downward, had made. The Mishna cannot be called a commentary, in the ordinary acceptance of the term, on the Pentateuch; for it does not elucidate seriatim the chapters and books of the sacred text; it rather professes to give an account of the manner in which the laws of the Pentateuch were legally interpreted and historically carried into effect. The Commandments and the prohibitions of the law are distributed under six heads named orders (סדרים), subdivided into treatises (מסכתות), of which there are sixty-three (some count sixty-two), composed of chapters (פרקים), 524 altogether, each of which contains a number of sections called *rules* (הלכות), amounting to 3829 for the whole Mishna. The first order treats of laws relating to agricultural produce (זרעים); the second (מועד) enumerates the festivals and their regulations; the third (נשים) contains the laws of marriage and divorce; the fourth (נזיקין) details the proceedings in questions of mine and thine; the fifth (קדשים) relates to the sanctuary and sacrifices; the sixth (טהרות) defines the notions of pure and impure in ritual matters.

From the arrangement of the contents, it is exceedingly difficult to infer the method followed by the author, as the connexion between the subjects discussed in the same chapter is not everywhere logically warranted. But here it must be remembered that the Mishna was not originally intended for publication in writing, but for *oral* transmission, however incon-

ceivable such an operation, with 524 chapters, and their aggregate of 3829 rules, may appear to a much-reading and little-remembering generation. To assist the memory various mnemonic artifices were employed, among which that of the *association of ideas* has ever been the most approved, and is at this day the golden rule on which teachers of the "art of memory" chiefly depend. If, therefore, in the Mishna, or other compendia of oral traditions, heterogeneous subjects are found strung together, seemingly on no principle whatever, the connecting principle is, in reality, that of "association of ideas." That the Mishna was not completed by Rabbi Judah is evident from the mention of his death (*Sotah*, ix. 15) and the quotation of more than one later authority in the body of the work; nor has the question of the date at which it was committed to writing been hitherto solved. One of the treatises only (*Aboth*) has a historical form: it describes the transmission of the oral doctrines from the beginning; the remaining treatises of the Mishna determine questions of law and practice. Before his death, Rabbi Judah is said to have made a few, though unimportant, alterations, which were adopted in Babylonia.

The Mishna, in its original form, became the text-book at the Palestinian schools, where it took rank before the several epitomes of the Tradition previously known and henceforward described as *external* Mishnas (*Boraitha*), and *additamenta* (*Tosiphta*), which were afterwards accounted to hold about the same relation to the authoritative Mishna as the Apocrypha did to the canonical books of Scripture (Gratz, *Gesch.*, iv. 257). Nearly coeval with the Mishna

are three commentaries, still extant (*Sifra*, *Sifri*, Mekilta), on part of the second and on the three further books of the Pentateuch. In these works, not the discussions and decisions of the doctors, as in the Mishna, but the elucidation of the *Biblical* word and phrase is the immediate object of the authors. This latter process is called Midrash (enquiry, search); it is applicable to a number of writings produced from the early commencement of exegetical studies down to the eighth and ninth centuries after Christ, which offer a vast homiletic *thesaurus* to the orator and the moralist. The Mishna and its above-mentioned auxiliary works are composed in Hebrew, rarely interspersed with Aramaic—that is, the dialect then vernacular in Syria, and the adjoining district between Euphrates and Tigris. But the Mishnic style exhibits many Hebrew new formations and numerous terms referring to science, commerce, trades, jurisprudence, agriculture, and domestic economy, altogether unknown to Biblical Hebrew. Upon these foundations was built up the great fabric of the Gemará (completion), which is neither more nor less than a commentary on the Mishna, *every line of which*, so far as the commentary extends, is subjected to a minute analysis, and is made the channel of numerous digressions into adjoining and into remote provinces of thought. The Mishna having been communicated by two of Rabbi Judah's immediate disciples (Rab and Samuel) to the schools in Babylonia, the same system of study in the two countries produced two Talmuds—one of Jerusalem or Palestine, the other of Babylon. Towards the end of the fourth century the political position

of the Jews in the Holy Land, under the rule of converted Rome, was deplorable. Fortunately there was then a place of refuge for many of them beyond the Euphrates, in the Parthian empire, which the sceptre of Rome did not reach. Palestine abdicated its religious hegemony. The patriarch Hillel II. (about 350) published the astronomical rules by which, joined to some conventional regulations, the annual festivals had been proclaimed, from the days of yore, by the highest central authority. The schools finally collapsed, the Palestinian Talmud was not finished, but brought to a stand-still, at Tiberias, some years after the reign of the Emperor Julian, whose name (Lulianus. compare the Italian *Luglio* for *July*) occurs in that Talmud (Jer. Nedarim, chap. iii. Hal. 2), although—which is strange—to the frustrated attempt of the apostate emperor to rebuild the temple in Jerusalem there is not the slightest allusion. From the days of Hillel and Shammai to those of the last Mishnic teachers (styled Tanaim) there is an interval of 210 years, divided into six periods of unequal duration (דורות, "generations." Frankel, ד׳ מ׳ ב׳, ק״ב). Great men adorned that memorable epoch in Jewish history: among them, Gamaliel and his descendants, Yoḥanan Saccai, Yishmael, 'Aqiba, Meir, Yehuda Al'ai, Simon Yoḥai, Nathan Babli—the lives of most of whom are narrated with commendable warmth in the great work by Grätz (*Gesch.*, vol. iv.), the effect of which is, however, occasionally marred by the unfavourable judgments unsparingly passed by that historian on anti-Talmudic religious doctrines and denominations.

The discussions in the Gemara of Palestine express

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the opinions of the Amoraïm ("expositors," the etymology is doubtful, either from אמר, "to say," or ירי, "to teach"), who, in six generations, cover a space of 230 years—from Ḥiya Rabah, a disciple of Yehuda or Judah the Saint, to the last doctors of Cæsarea, in the first third of the fourth century.

Rabbi Yose Bun, contemporaneous with the emperors Julian, Jovian, and Valentinian I. (361–375), was the last of the *great* Amoraïm of the Talm. Hieros, the authorship of which is generally attributed to Ioḥanan, at Tiberias; but, as the last-named rabbi died in the year 279, he must be understood to have *commenced* the compilation, which was finished a century later (Frankel, *Mebo Hayerushalmi*, pp. 2, 102; Maim. *Yad*, preface; Sherira's *Letter on the Talmudical Succession*). The lives, the acts, and characters, of the Palestinian Amoraïm are minutely described in Frankel's highly instructive work (pp. 55–131).

The much more copious Talmud Babli (of Babylon), the growth of which may be learnt from Fürst's *Kultur- und Literaturgeschichte der Juden in Asien*, contains the record of the transactions of the Babylonian schools. In the year 188 (Fürst, p. 39), Abba Areka (Rab) introduced the Mishna at Nehardea, where at that time Shela officiated. At Shela's death (in the year 219), Samuel Yarḥinaï, a great physician and astronomer, became the rector of that school, and Rab was elected to the similar post at Sura (or Sora). Their fame attracted numerous students. Rab had as many as 1200 disciples, 125 of whom are mentioned by name in the Talmud, a number unattained by any of his successors. In the year 258 Nehardea was sacked

by the robber-king Papa ben Neṣer, a condottiere, under the auspices of Odenatus, the consort of the famous Zenobia, then at war with the Persian King Shapur I. The *School* at Nehardea never regained its former rank; the teachers sought or founded new seats of study, and thus Pumbeditha, Maḥuza, and some minor places, rose into importance of more or less duration. The Jewish *colony* at Nehardea revived, however, after the fall of Palmyra. Rabbi Ashe, rector of Sura, in the year 374 set about collecting materials for publishing the *Transactions of the Babylonian High Schools*, to which Rabbi Abina gave the shape of the Talmud Babli 124 years afterwards, likewise at Sura. Seven "generations" of Amoraim had co-operated in the work. As the precipitate closing of the Yerushalmi had been prescribed by political necessity, rather than by literary convenience, so the Talmud Babli was published under the accelerating pressure of great national suffering. The Sassanian kings of the fifth century persecuted both the Jews and the Christians within their dominions systematically. From the beginning of the reign of Yezdejerd II. in 442, until far into the reign of Qobâd, 491–531, hostility to the Jews was the rule; it culminated under Firûz (461–488) in the incarceration and execution of men in eminent position, followed up, in 473, by a royal decree to shut *all* the schools and to enforce the adoption of Persian laws. As a matter of course, the schools were re-opened after a short reign of terror, and the laws of the Medes and Persians were never adopted at all; but the complexion of the times justified the worst fears and rendered most advisable

the setting of the house in order. There were teachers after Rabbi Abina, but they were no longer Amoraïm, whose decisions were binding; the Epigones of those latter days were styled Seboraïm ("decisores," from סבר, to infer, to opine: Grätz): their dicta required corroboration by higher, *i.e.*, older authorities. Their title is first met with at the beginning, and disappears about the middle, of the sixth century (Grätz, v. p. 425), when Giza and Simuna, the last of the Seboraïm, "sealed" the Talmud of Babylon. Since then there has existed no power to add to or to diminish aught from the contents of that work. After an interregnum of a century the Geonim ("excellencies"—a word of uncertain, probably non-Hebrew, etymology) were recognised by the civil power as heads of the re-constituted academy at Sura. Yiṣḥaq (Isaac) was the first Gaon solemnly inducted into his office, in 657, under the Khalifate of 'Ali. In the course of that century, between the last of the Seboraïm and the first among the Geonim, the rule of Asia had changed hands—for, in the month of April 571, Moḥammed was born at Mecca, and in September 622 he fled with Abu Bekr from Mecca to Medina.

Neither of the Talmuds can be considered a complete work, since neither of them extends over all the six "orders" of the Mishna. It cannot be admitted that the non-extant "orders" were intentionally disregarded because they treat of subjects then no longer of national importance—since many questions (relating to the Temple service, wars, and conquests) largely discussed in the Mishna and the Talmud were at the time perfectly obsolete, without being, on that account,

neglected in theory. Some missing portions—this can be historically proved—have undoubtedly been lost after a temporary circulation among the learned; but the truncated condition of the two Talmuds is substantially explained by what has been stated before, viz., that the two collections were *discontinued*, rather than *closed*, through the force of external circumstances, very much to the regret of those interested in the labour. If *ex ungue leonem* were anything like an arithmetical formula, the proportions into which a *complete* Talmud would have developed might be inferred from the fact that the torso of the Babylonian Talmud now in our possession, without its companion, is composed, including the marginal gloss, of 5894 folio pages. The language is the Aramaïc, tinged with provincialisms belonging to the two countries which produced the Talmuds; all quotations from the Mishna and the Bible are everywhere in Hebrew.

The printed editions which, particularly in the case of the Babylonian, are by no means rare, are in a very unsatisfactory condition, owing to the carelessness or the ignorance of the editors. Those published under the censorship of Christian ecclesiastical authorities were, moreover, purposely mutilated, or, as it was styled, expurgated; void spaces being left wherever those learned men fancied to detect allusions disrespectful to the State religion. But all these passages are found, with their native semblance on, in editions of the Talmud published in Constantinople, and they are now unceremoniously reproduced in Central and Western Europe—the conviction having gained ground that the Christianity of this age has nothing whatever to fear

from *that* quarter—especially, as it is far from probable that in those suspected passages there is any reference to Pauline Christianity at all. Altogether, the history of the rise and progress of the Church receives no light from the Talmudic Traditions. The Mishna, although dating from the end of the second century, betrays no knowledge of the existence of Christianity. Hypotheses enough might be started to explain this silence, or ignorance, or reticence; but they could prove nothing. An *argumentum a silentio* is not conclusive. Shakespeare *did* exist, although his contemporary, Lord Bacon, does not mention him. The Babylonian Talmud nowhere shows any knowledge of the existence of such a work as the Talmud of Jerusalem, although surely occasions of manifesting such knowledge must have occurred frequently. Even the very learned S'adia of Fayûm, who was Gaon at Sura from 928 to his death in 942, four *centuries* after the publication of the Yerushalmi, was unable to contradict Salmon the Karaïte, who quoted the Talmud of Jerusalem against the Talmudists, because "the Yerushalmi was not *then* known in Babylonia" (*Mebo-ha-Yerush.*, p. 132). In neither Gemara are Christians or Christianity mentioned by name. There are indeed allusions to disputations between the Doctors and certain querulous people denominated "Minim" (heretics), whom some writers persist in making into Christians; but this term is so vague, that it is applicable to any of the numerous sects, or branches of sects, which in those ages filled, not only Palestine, but all Asia, Egypt, and the classical lands of Europe, with the tumultuous excitement of religious warfare. As

the controversies alluded to in the Gemaras have, in most instances, some divergent interpretation of a Mosaic law in view, it is highly probable that those disputes lay between the Talmudic doctors and such Jews as had, like the Ebionites and Nazarenes, adopted some of the dogmas of Christianity, without, however, leaving the pale of Judaism by rejecting the Law of Moses; but Pauline Christians, mainly of Grecian birth, and in whose opinion the Mosaic Law was no longer obligatory, were certainly regarded by the rabbis of the Talmud as Gentiles to all intents and purposes, between whom and the teachers of the Law there was no common ground left for discussion, and no discussion took place. At the same time, the Talmud undeniably affords considerable aid for the elucidation of the phraseology and modes of thought of the New Testament, if not of its history.

A brief notice may be due to the much vexed question—whether the founder of the Christian religion is described in the Talmud under the name of Yishô Nôṣri? The public censors (ecclesiastics) without whose "imprimatur," as long as their office was recognised, no Talmud was printed in Europe—decided affirmatively; in consequence, they expunged many passages referring to that name although, when wanted for polemical purposes, the withdrawn extracts were always ready to hand. (See G. H. Vorstius, *Chronol. Sac. Prof.*, p. 257; Wolf, *Bibl. Heb.*, ii. p. 979; Wagenseil, *Sota*, p. 1052, and, above all, Eisenmenger, *Entd. Judenth.*, vol. i. *passim*). The Gospel history being well known, it only remains, for the purpose of making a comparison possible, to give an outline

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of what the Talmud really states (without the uncharitable or fantastical comments for which the Talmud is not or ought not to be accountable) on the subject. When Alexander Yannaï (Jannæus, 104–78 B.C.) was king, Rabbi Yehoshua ben Peraḥia, to escape the persecution then raging against his party, the Pharisees, withdrew to Alexandria and took with him a young scholar, named Yishô Nôṣri. After a while, the exiled rabbi was encouraged to return home in a letter from his colleague Shim'on (Simon) ben Shetaḥ, who had remained at Jerusalem under the exceptional protection of his intimacy with the royal family.

During this journey it was that Rabbi Yehoshua was so offended at the manifest levity of his youthful companion, that he solemnly excommunicated him, unmoved by Yishô's solicitations to be re-admitted to his religious status. One day, however, after prayers, the teacher, seeing his pupil approach, was touched by what he construed into a sign of contrition, beckoned to him to come forward and to receive a pardon. But now Yishô refused, protested that he never would or could return to obedience, and set up an idol which he worshipped and induced others to worship. This subsequently brought upon him a sentence of death by lapidation and strangulation, executed upon him and his five disciples, viz., Mathaï, Nigaï, Neṣer, Bûni, Thôda, on the eve of Passover, after a proclamation had been made to no effect for forty days to invite witnesses to come forward on their behalf against the charge of magic and sedition (*B. Sanhedrin*, 107, col. 2; ibid., 43, col. 1; and parallel passages.) The biography of the Talmudical Yishô Nôsri extends no

further. Wherever else invectives are met with in the Talmud against one Ben Stada, ben Pandira, ben Pappus, ben Yehudah, not even the name of Yisho is mentioned in connexion with them, and it was only on the inspiration of the *odium theologicum* (which in the Middle Ages was all powerful with Jewish and Christian controversialists alike) that a connexion could be attempted, the chronological data being, in every instance, against the sense-confounding insertion. It is no doubt easy to deny the historical existence of the Talmudical Yishô; but it is not so easy, nay, the very contrary of easy, to disprove it, and, if his historical existence cannot be set aside, it must for ever remain impossible to link the accounts of the Talmud to those of the gospels, either for mutual support or destruction. The very forms of the name employed in the gospels on one hand and in the Talmud on the other, greatly enhance the difficulty. Well may J. Lightfoot say: "Non plane mihi satisfit de vulgari scriptura vocabuli Nazareth per נצר (Neṣer), multo minus quod Nazarenus proferatur per נוצרי id est Νωζαραῖος, cum amanuenses sacri dicunt Ναζωραῖος" (Opera, t. ii. p. 578). He might have added that to represent Hebrew צ by Greek ζ was contrary to established usage. (Gesenius *Lehrgeb. d. hebr. Spr.*, p. 21; "צ bei den LXX durgangig Σ." *)

* Mishna and Talmud recognise the existence of sacred mysteries, the indiscriminate propagation of which they deprecate. The theory of the "Creation" revealed in Genesis (Chap. i. מעשה בראשית), and that of the heavenly "Throne" in the visions of Isaiah (chap. vi.) and Ezekiel (chaps. i. and x.) typified by the *Chariot* on the Ark in the Temple (1 *Chron.* xxviii. 18) (מעשה מרכבה), formed the

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The texts of the Talmud are composed of *two* elements which it is essential not to confound. First,

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subject of these mystic traditions, which, when collected and systematised in writings, attracted more general notice in post-Talmudic times, from the period of the Geonim (about 8th century) downward. Under the special title of *Qabbalah* (Kabbala, from קבל, to receive), a term used in former times more generally, of *all* knowledge *not* obtained from the written law, the mystic Science of the Jews began to be cultivated with vigour about the 13th century; first in the South of Europe, but soon by means of a rapidly growing literature, chiefly in the Aramaic dialect (probably with a view to keep its circle of readers select), it spread in all directions, even beyond the sphere of Judaism. The antiquity claimed by Kabbalists for some of their books is of course disputed. Few will admit that the Hebrew "book of Creation" (ספר יצירה) is the work of the Patriarch Abraham; there is, however, nothing extravagant in allowing either Rabbi 'Aqiba, the Tana, of the 2nd century, to whom some of the "Science" attribute its authorship, or some less illustrious contemporary of his, to have composed the work. The fact that *a* book *Yeṣirah* is mentioned in the Jerus. Talmud (*Sanhed.*, fol. 25, col. 4), and that the great Sa'adia, Gaon of Sura (died 942), wrote a Commentary on the book now extant under that name, pleads in favour of such an admission. (Ad. Franck, *La Kabbale*, p. 76, 90. Comp. Zunz, *Gottesd. Vortr.*, p. 164.)

The age of the book Zohar (זֹהַר, light), the very Bible of the Kabbalists, has given rise to a much more animated controversy not yet definitively set at rest. The Kabbalists themselves maintain that the venerated Tana Shim'on (Simon) ben Yoḥaï, a disciple of the frequently mentioned Rabbi 'Aqiba, revealed the Zohar to his son in the cave where, as the Talmud relates, they sheltered for thirteen years to escape from the vindictive persecution of the Romans (*B. Sabb.*, fol. 33, col. 2). Even in the present century, learned men, both of the Church and the Synagogue, have supported this account of the origin of the Zohar, undismayed by the startling anachronisms involved. Others modify this view by attributing the foundation of *the system* to the *school* of Yohaï, and the gradual composition of the Zohar to various hands, from the beginning of the Christian era to about the 8th century—a period in which the mysticisms of the Gnosis, of Neoplatonism, Sabism, Manichæism, Buddhism, came in collision with Judaism and Christianity in Asia and Egypt (Ad. Franck, p. 113.

the *legal decision*, Halakah (הלכה, corresponding with the biblical משפט, *judgment*, see Targum on *Exod.*

135) Landauer (*Orient. Litbl.*, 21 et seq.) adduces a mass of evidence to show that the fabrication of the Zohar is chargeable to Abraham ben Samuel Abulafia, born at Saragossa in 1240, a wild enthusiast, among whose more striking vagaries may be reckoned the attempt (for which he was consigned to a dungeon) to induce Pope Martin IV. in the year 1281 to renounce the Catholic religion.

Jost, while admitting the correctness of many of Landauer's arguments, reduces Abulafia's share to that of a collaborator in the production of the Zohar, in which Jost recognises numerous fragments of high antiquity (*Judenth.* 3. *Abth.* p. 77). After an elaborate revision of the subject, Gratz decides that, on good external and preponderant internal evidence, the Zohar is the production of Moses ben Shem-tob de Leon (1205–1305), described by him as an unprincipled adventurer with some talent but little learning, who hit upon publishing the sensational Kabbalistic Revelation as an expedient for the reparation of his shattered finances (Gratz, *Gesch.*, vii. p. 231, and note 12). The Zohar is not on the best of terms with the Talmud. It may, without injustice, be asserted that the consistent Kabbalists to whom the Zohar and its Commentaries are "the Law and the Prophets," slight the traditions of the Mishna and the Gemara; the Bible itself is deemed by them worthy of respect, only when viewed in the light shed upon it by their great "luminary."

The mysteries of "the Creation" and those of "the chariot" were not absolutely excluded from the speculations of the Talmudic doctors, but they were not part of obligatory study. On the contrary, "whoever speculates on four things," says the Mishna, "(so endangers his soul that) it were better for him he had never been born, viz., on what is above the visible world, on what is beneath, on what was before Creation, on what will be after its destruction;—he that does not hold sacred the reverence due to his Maker, for him also it were better he had never been sent into this world" (*Hagigah*, ii. 1). "Four men," says the Gemara, "rose towards Paradise" (פרדס, an epithet for the *study* of the heavenly mysteries, because it ventures into a region impenetrable to man in his *mortal* state) "viz. Ben Azai, Ben Zoma, Aḥer (the Other), and Rabbi 'Aqiba. None but the last returned in safety. Of the rest, 'Azai lost his life and Zoma his reason; as for Aḥer, he *destroyed the plantations*" (*i.e.* he became an infidel) (*Bab. Ḥagigah*, fol. 14, 2). The meaning of this tradition

xxi. 9), which is considered binding on all who recognise the authority of the tradition. The process of deducing the *Halakah* from the intricate Talmudical discussions is one which requires extensive knowledge and high critical powers. The practical importance of codifying the numerous Halakoth has led to the publication of several digests of Rabbinical law, dating from the eighth century to the sixteenth; the earliest by Shim'on Qahira, who died at Pumbaditha in 751 (הלכות גדולות), the most recent by Moses Isserles, who died at Cracow in 1573 (מפה על השלחן הערוך). Secondly, the Haggadah, "the Saying" (from הגיד "he said"), which is not invested with any legal authority; its declarations are obligatory on no one, and the interpretation of them is at the mercy of an unfettered imagination, or, as the case may be, of matter-of-fact rationalism. The Haggadah comprises

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is transparent enough, and so is its tendency, viz. to warn against the search after that which lies beyond the limits of the human understanding. Of a like character is the following direction: "The laws on the forbidden marriages ought never to be explained to three hearers, or the history of 'the Creation' to two, or the nature of 'the Chariot' to one, unless he be a perfect scholar, able to draw conclusions for himself" (*Mishna Ḥag.*, chap. ii.).

Aḥer's real name was Elish'a ben Abuyah. Notwithstanding his defection from the faith, to the extent of denying a future state and retributive justice, his memory is dealt with almost tenderly in the Talmud, in consideration of his vast learning. The great teacher, Rabbi Meïr, once his pupil, frequently endeavoured to reclaim his still beloved master by the power of friendly colloquies on Providence and kindred topics. While Aḥer lived, he would not retrace his steps; but, in the opinion of Rabbi Meïr, he died penitent (*Yerush. Hag.*, fol. 77, cols. 2 and 3). The character of the Talmudical sceptic is idealized with masterly skill by Carl Gutzkow in the drama *Uriel Acosta*.

all the Talmudical allegories, parables, hyperboles, historical *morceaux*, proverbs, popular sayings or sage maxims, ingenious or pathetic references to scriptural facts and examples, in short, all that serves to point a moral or adorn a tale (See *Introd.* to the Gemara, by Rabbi Sam. Ha-Nagid, prefixed to the editions of the Talmud).

The *Halakah* and the *Haggadah* are not, however, marked off by a hard and fast line of division; they overlap and interlace each other very frequently in their course, and to pursue with accuracy the thread that runs zigzag between Halakah and Haggadah requires a practised eye besides a powerful motive for the taxing exertion. Hence the perplexity of the amateur tourist who, in quest of a startling Halakah or of a telling Haggadah, ventures to penetrate without trusty guides into the Talmudic forest, where he finds himself in the presence of a wilderness of rigid consonants, with not a single vowel-point to light up the path, without a single finger-post in the shape of a comma, or a note of interrogation in the midst of queries and replies undistinguishable by their outward appearance, and hence, the singular plans and descriptions of the region visited, brought home from such unfortunate explorations.

The reader of the Talmud who has no preconceived judgment to uphold, cannot help being unequally impressed by the very mixed character of its contents. The defects of the Talmud are at once conspicuous. The Halakah offends by the microscopic attention it bestows on many questions of ceremony and ritual observance which ought never to have occupied so

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much of the time of grave men clothed with authority over a whole people.

No doubt the *tu quoque* argument may be appealed to against many an objector. The Talmudical is not the *only* religious system in which ceremonies and symbols are raised to an eminence which the uninitiated cannot equally appreciate. The effect, however, remains the same, to the prejudice of the Talmud and its minutiæ. The Haggadoth, on the other hand, cannot be absolved from indulging on too many occasions, in undignified, nay gross exaggerations never to be explained away by a facile reference to the Oriental fashion of telling entertaining tales, or, still worse, by the supposition of hidden truths underlying the fabulous covering; for that mysterious sublimity is a gratuitous assumption justified by no evidence presentable to common sense. The only apology possible is, that not *all* the Haggadoth are liable to that charge, and that *no* Haggadah whatever is looked upon as an article of faith, but may simply be taken for what it is worth.

Religious tolerance is not exhibited in the Talmud to any greater extent than in *any* ancient writings, whatever their source. Genuine tolerance, that is, a respect for the religious opinions of those of a different faith, is a production of the most recent period of time, and is now only struggling into a more vigorous existence; it has no ancient, it has no modern history—its glories lie in the future before us.

While the *religions* of heathendom are condemned, the largest philanthropy is recommended, in the Talmud, towards *all* classes of human beings. "Feed the hungry among the idolaters," says the Talmud, "clothe

the naked, mourn with the bereaved, and bury their dead, to the end that peace and good will may prevail among *all* the families of man" (*Babl. Gittin*, fol. 61, col. 1). There is a beautiful fiction in the Haggadah: "When the Egyptian host lay dead on the sands of the Red Sea, the heavenly choir chanted hymns before the throne of the Almighty. But the Lord forbade them, saying, 'The Egyptians are the work of my hand no less than the Israelites'" (*Bab. Sahedr.*, fol. 39, col. 2). The liberality of which the Talmudists were capable manifests itself in the grand maxim adopted, "The upright of whatever creed shall inherit a portion in the world to come" (*Sanhed.*, 105, col. 1).

The scientific knowledge to be met with *incidentally* in the Talmud, is considered, by competent judges, to have been quite on a par with the acquirements of their gentile contemporaries. There are Hebrew expressions for terms in astronomy, such as planets, comets, the milky way, the signs of the Zodiac, &c., a fact which may be admitted as a proof that the study of that science was indigenous to, or at least acclimatised in, the Tradition.

The peculiar calendar of the Jews which was known in Talmudic times, though published after the close of the Talmud, is admired by Joseph Justus Scaliger, an eminent authority, for the accuracy of its system, which will require no emendation, will suffer no perturbation in thousands of years to come. It is also believed that the rational study of the Talmudical writings now coming into cultivation, will add valuable data to the *history* of medicine and of the natural sciences in Asia.

In fact, if it be remembered how famous the Jewish physicians became throughout the middle ages, it is impossible to exclude the belief that a notable share of their knowledge was *inherited* from the sages of Tiberias and of Sura.

The Talmudical standard of ethics is high. Truthfulness, purity, humility, temperance without asceticism, these are the heads under which the numerous attractive sayings may be registered that have secured a celebrity to the Talmud among learned men of all confessions.

The most remarkable treatises of the Talmud are those on jurisprudence. The judgment of such a man as Professor E. Gans, the great German jurist who knew the Talmud well, cannot be disregarded. He says (*Erbrecht*, I, p. 151, &c.) that no Corpus Juris known to *him* gives evidence of so much critical labour and penetration as the Talmudical law on inheritance and succession. The procedure in criminal cases prescribed in the Talmud is marked with the stamp of humanity in almost every particular. A specimen of the very advanced ideas entertained by some leading teachers of the Tradition on the subject of capital punishment is supplied by the Mishna. "A court that passes a sentence of death once in a week of years is indeed a pernicious tribunal. Rabbi El'azar added, 'I hold it to be such, if it does so once in seventy years.' Rabbi Tarphon and Rabbi 'Aqiba declared, 'If *we* sat in judgment, we should on no account vote for the execution of *any* criminal.' Then Rabbi Shim'on objected, 'Well, these men would only increase the shedding of blood in the country'" (*Maccoth*, I, 10). This discussion is short, but nothing of any moment

has been *added* to the argument, whenever and wherever this difficult question has been mooted in times nearer our own.

The data here furnished are far from sufficient to warrant a definitive verdict on the merits or demerits of the Tradition, nor did the writer, when he undertook to draw this sketch, indulge in the hope of being able to produce anything like such an effect; but he may conclude with the expression of his own opinion that there is in the Talmud many a thing to be regretted, but much more to be respected; that the difficult study of the Jewish traditions carries with it a high intellectual reward, and, as for the *repository* of these traditions, viz., the Talmud and its accessories, that it has been aptly called for its breadth and its depth, for the numerous objects of uncommon formation to be discovered in its recesses, and also for the dangers incurred by those who traverse its surface without an

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XI.

PROVENÇAL POETRY IN ANCIENT AND MODERN TIMES.

"FIGURE to yourself the first man when, after his creation, his eyes wander for the first time over his new empire; represent to yourself, if possible, the deep vivacity of his impressions when the magnificence of the three kingdoms reflects itself in the intelligent mirror of his soul: beside himself, elated with joy, almost mad with admiration, gratefulness, and love, he raises up to heaven his beautiful eyes, which the aspect of the earth will never tire; then, seeing God in that Heaven, and attributing to Him all the honour of the beauty, the freshness, and the harmonies of creation, he opens his mouth; the first trembling of speech moves his lips, he is about to—speak? No, no, he is about to sing, and the first song of this king of the earth will be a hymn to God, the Creator."

The author* of the foregoing passage thus intends to point out that the first kind of poetic expression of mankind was *Lyric* Poetry. And, in fact, men feel before they act, and, at all times, they have been able to find a poetic way of expressing their feelings. Thus,

* Gautier, *Épopées françaises*, i. ch. 1.

with the Greeks, Lyric Poetry preceded their Epopee; Orpheus sang before Homer. Another confirmation of this fact is to be found in the literature of France during the Middle Ages, in which the Lyric Poetry of the South preceded the Epic Poetry of the North.

After a long succession of sufferings, to which the inhabitants of Europe had been exposed in consequence of war and anarchy following the downfall of the Roman Empire, their minds were, so to speak, held captive in a fatal torpor, from which they could rouse themselves only by a hard and prolonged struggle. When at last they awoke to a new and fruitful activity—about the eleventh century—everything around them had been changed: religion, language, manners, and whatever had formed part of the old heathen world; a few traces only were still to be found of Greek and Roman civilisation. Europe had been converted to Christianity; Chivalry opened a new career for heroism, and the Crusades produced a profound and universal activity. The natural and inevitable result was an unprecedented multitude of new sensations, new ideas, and new aspirations.

The first who gave expression to these new tendencies were the Troubadours. Their writings, more than anything else, enable us to understand and to appreciate the manners, opinions, tastes, and prejudices of the times in which they lived. This new kind of poetry first showed itself in Provence, "the garden of the Hesperides, which poets and writers have never tired in praising for its luxurious climate, producing the perfumes of Arabia together with the

riches of the Orient, of Spain, and Affica."* In this beautiful country life flowed on in soft ease. The owns still enjoyed important liberties and privileges,† The great barons, especially William of Poitiers, the Counts of Toulouse, those of Provence (the Bérengars), loved and encouraged arts and poetry; emperors and kings opened to the *Gaie Science*‡ the halls of their palaces; during nearly three centuries the Troubadours were among the most perfect and magnificent interpreters of the ideas of Christian Europe. Having attained as early as the eleventh century § to that degree of intellectual culture which is necessary for the expression of thoughts in a poetic form, they reached their highest point of glory in the twelfth century. But only too soon—*i. e.*, from about 1230—they began to lose their well-merited renown, and from the end of the thirteenth century till quite recent times Provençal poetry, with a few praiseworthy exceptions, has been of so little importance that, in the eyes of the world at large, it may well be said to have been extinct. It was, therefore, a matter of great wonder to most people, and of intense delight to those few who had kept up the traditions of the past, when this poetry began, in the present century, to show new signs of life; when, like a powerful plant, it brought forth luxuriant blossoms, sweet flowers, and delicious fruits, which may well challenge comparison with the finest literary productions of modern times.

* *Mercure de France*, N. 7, p. 107.
† Papon, *Hist.* ii. 214, sq. Wachler, *Lehrbuch*, p. 208.
‡ Bruce-White, *Histoire*, &c., ii. 178.
§ Wolf, *Wiener Jahrbücher*, 1834, lxvi., p. 101.

To attempt a rapid survey of the origin of this poetry, of its decline, and, lastly, of its revival in the nineteenth century, is the object of the following pages.

I.

Although, as has been seen, there are some reasons which account for the rise and growth of the literature of Southern France; yet its origin and high perfection constitute a most curious and striking phenomenon in the history of mental culture. There is scarcely anything more interesting than to witness the rise and gradual developement of poets who, like the Troubadours, are without any connexion with the intellectual traditions of former times. Several theories, it is true, have been brought forward, in order to explain what is called Romantic Fiction * in Europe, of which we discover the first signs in the literature of French and Provençal poets.

According to some, romantic fiction was derived from the poets of the Franks and Saxons, and from the northern Scalds;† others maintain that it was derived from classical mythology, and that it is nothing but a reproduction of the ancient literary remains of Rome and Greece, adapted to the manners and customs of modern Christian times. As for the Troubadours, there is so little affinity between their poetry

* I use the term *Romantic* in its widest sense, *i.e.* that kind of literature which, totally unknown to the ancients, and distinct from classical literature, was inspired by Christianity and by the chivalrous and feudal institutions of the Middle Ages.

† Mallet, *Introduction à l'Histoire du Danemarc.* Percy, *Reliques of Ancient English Poetry*, p. xix., sq.

and that of the Romans and Greeks, that they owe hardly anything to the writings of classical antiquity.* A third theory is that which derives romantic fiction from the Arabians. This theory was first suggested by Salmasius, and, after him, followed out by Warton in the first volume of his *History of English Poetry*. Similarly Ginguené and Sismondi maintain that Provençal literature is a perpetual imitation of that of the Arabians as regards both form and matter, a belief which Villemain † has also adopted. This seems to me just as little probable as the opinion of Schlegel, who rejects *every* kind of Arabian influence. For the Troubadours were, no doubt, acquainted with the poetry of the Arabians. Although, indeed, they made no particular study of Arabic poetry, nor collected its numerous love songs (the Ghazelles or Cassides) in order to reproduce them in their own language, it is not the less certain that the intercourse of the Catalans and Provençals with the Saracens, whose civilisation was as brilliant as it was transitory, the interchange of ideas between the two races, nay, even their wars, exercised a certain general influence on the thoughts and imagination of the former. Although there is between the literature of the Arabians and that of the Provençal poets too little analogy and resemblance to allow the

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* Mary-Lafon, *Les Troubadours ont-ils connu l'antiquité?* Paris, 1839.

† *Littérature du moyen-âge*, vol. i. Villemain goes even further than this when he maintains that Oriental influence has been felt even in modern times, for instance, "in the mystic fervour of the Germans, with whom the first model of eloquence in popular language was the version of the Bible by Luther." The same influence, he adds, is also seen in the works of Shakspere, whose language "abounds in Orientalisms!"

conclusion that the former was the type and the immediate source of the latter, yet we must admit that a certain number of ideas, more particularly originating in the vivid and fiery Eastern imagination, have, by a thousand channels and *détours*, found their way into the poetry of Southern France. As to the outward garment * of this poetry we know that the Troubadours borrowed from the Saracens several of their poetical *forms*, as, for instance, the *Tornada* (Fr. *Envoy*), the *Tenzon*, and probably some of their more artificially arranged rhymes, although not the use of rhyme itself.

The origin of rhyme, which plays so important a part in Provençal poetry, has been often enquired into by the learned of France, Italy, England, and Germany.† As to none of the several enquirers it appeared to be of native growth, each traced its use by his own people to a foreign source. A scholar of the sixteenth century even went so far as to assert that rhyme had been invented by Japhet. The fact is that rhyme is very old; we find many a proof of this in the Roman authors. Cicero cites the following passage of the old poet Ennius (born about 239 B.C.):—

Hæc omnia vidi inflamm*ari*
Priamo vi vitam evit*ari*
Jovis aram sanguine turp*ari*; ‡

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* Quadrio, *Storia e ragion di ogni poesia*, vol. vi., l. 2, p. 263. Schmidt, *Wiener Jahrb.*, vol. xxvi. p. 24. Ideler, *Altfranzös. Nationallitterat.*, p. 51. Ginguené, *Histoire littéraire d'Italie*, i. 263. Huet, *Sur l'origine des romans*, p. 359 (contained in *Ana*, or *Collection de bons mots*, &c., vol. viii.

† Fauriel, *Histoire de la poésie provençale*, iv. ch. 39 and 41. Ideler. *l. c.* p. 51. Disraeli, *Amenities of Lit.*, ii. 270, 273, sq.

‡ These assonances recall the hymn of Latin rhymes composed

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and then he exclaims, "O poetam egregium! Præclarum carmen! Est enim et rebus et verbis et *modis* lugubris."

I think it reasonable not to deduce the use of rhyme from any particular people, but to consider it as universal as poetry itself; and, therefore, I hold that its use naturally suggested itself to the Provençal poets, who desired to please, not only by the artistic form of their poems, but also by the repetition of certain combinations of sound agreeable to the ears of their hearers.

To return, then, to the question as to the real inventors of romantic fiction and romantic literature generally: my belief is that, in a certain sense, the Troubadours are to be considered as its inventors. For the Provençals, enjoying peace and comfort under exceptionally favourable conditions, while the other European nations were still suffering from wars and social and political revolutions, were before them inspired with the genius of poetry in a country equally remarkable for the mildness of its climate and for the beauty and fertility of its soil. They were the first who found means to cast in a poetic form those ideas which, together with the humanising principles of Christianity, had gradually become the *common property* of the various Occidental nations after the overthrow of the Roman Empire, and especially after that

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by Thomas of Celano, about 1210 A.D., giving us so striking a picture of the Last Day of Judgment, and known to all by the requiems of Cherubini and Mozart:

> Dies iræ, dies *illa*,
> Solvet sæclum in fav*illa*,
> Teste David cum Sib*ylla*.

period when the Teutonic tribes had founded more or less lasting establishments in all the provinces of ancient Rome. Since we know that, as regards customs, religious belief, and political institutions, there has, in the history of mankind, scarcely ever been a greater change than in the Middle Ages, is it not natural that we should also look for a corresponding alteration in the *literature* of those times, inasmuch as every literature must needs vary and change with the society and civilisation of which it is only the result, the outward manifestation?

Thus, in the literary productions of the Provençal poets we see, for the first time, a picture—more or less beautified or exaggerated—of modern times, of the state of civilisation, of the ideas and sentiments, of modern Christian and chivalrous Europe.

What, then, has been the history of that small tract of land where the Troubadours lived and sang—the Provence?

Shortly after the Second Punic War—221 B.C.—the Romans sent an army across the Alps, which conquered the southern part of Gaul. The territory thus acquired was called by them *Provincia* Romana (hence the modern word *Provence*), in opposition to the part of Gaul which had not yet been subdued by them. From this *Provincia* the Romans gradually extended their dominions until, under the leadership of Cæsar, the whole of Gaul was brought into subjection from 58–49 B.C. Augustus divided the whole country into four districts, of which Gallia Provincia (sometimes called Narbonensis) formed the south-eastern part. After having been for some time in the power of the

Visigoths (after 419 A.D.) and of the Ostrogoths, the Provence was, in 536, incorporated by Theudebert with the Frank monarchy, with the whole, or one of the divisions, of which it remained united till 855. In this year King Lothar instituted his third son (Charles II.) King of "Provence." This date is of importance, as marking the first step towards what was afterwards more permanently accomplished. In 876 Charles the Bald made Boso of Autun Governor of Provence and Lombardy. Not content with so subordinate a position, Boso made himself altogether independent, and was acknowledged as king by the Provençals in 879.* He became the real founder of the kingdom of "Provence," or "Burgundy," sometimes called that of "Cisjurane Burgundy," which, having been, in 937, united with "Transjurane Burgundy," was called the "Kingdom of Burgundy," or "Arles" (Arelat). This was included in the Germanic Empire when, in 1037, the Emperor Konrad II. acquired the possessions of Rudolf III., the last of the Burgundian or Arelatic kings, who had died in 1032.†

From this it appears that Provence, although at one time forming part of the Frank monarchy, had practically always enjoyed an independence of her own, and constituted, up to the time when her first lite-

* Papon, *Histoire Générale de Provence*, vol. ii. pp. 127-132. Raynouard, *Choix*, &c., vol. iii. Eichhorn, *Erläuterungen*, p. 58. E. Taylor, *Lays of the Minnesingers*, p. 69, and cf. Bryce, *Holy Roman Empire*, *Appendix A*; and Spruner's *Hist.-Geog. Atlas*, p. 17 and the respective maps.

† It was only four centuries later, *i.e.* in 1486, that Provence was definitively and for ever united to the Crown of France by Charles VIII., son of Lewis XI.

rary efforts were made, a State, or part of a State, altogether separate from Northern France, obeying different laws and different in its social and political institutions. There was consequently very little in common between the inhabitants of the South-east and those of the North of what ultimately became the united modern kingdom of France.

In fact, the Provençals, "these refined Italians," originally differing from their northern neighbours in nationality because their country had been more thickly populated by the Romans than any other part of Gaul, found themselves still further alienated from them by political animosity and jealousy.* We can, therefore, not be surprised to see that not only the customs and manners, but also the language and literature of these two parts of France widely differed from each other; and the question I accordingly now wish to propose is, What are the distinctive spirit and poetic character of Provençal Poetry?

One of the principal features of the Middle Ages is the recognition of the fact that Christianity assigned to woman a new place in the social order of the world, very different from what it had been before. The deep respect accorded by that epoch to woman could not but exercise a most powerful and beneficial influence on humanity; for when man, confident in his physical force, reigns alone, we can never expect to

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* Bouterweck, *Geschichte der Poesie und Beredsamkeit*, v. p. 6. Eichhorn, *Geschichte der Künste*, i. p. 146 sq. Eichhorn, *Erläuterungen*, p. 58.

see real human culture develope itself. There now arose a new kind of worship of the Beautiful, and of female beauty in particular, and that in a higher and more refined sense than had been the case with the non-Christian world. The Greeks, the Romans, and the Arabians had bestowed praise on woman, as necessary to their happiness, but they treated her only as an inferior, and even as a slave. The Christian world set before itself a new ideal. What man now strives for is, that the lady whose affection he endeavours to win should recognise his personal worth; that she should prefer him to other suitors, that she should love him, because she honours and esteems him. Such a demand is based upon the supposition that man considers woman as his equal, nay, that he looks up to her as a superior being; the endeavour he makes to *deserve* the favour of her he loves, and to become worthy of her, reacts on his own conduct. Love raises him above all that is common and vulgar; it becomes with him the mainspring of every noble action; he can henceforth neither do nor say anything of which he would feel ashamed before her. The Teutonic nations especially seized the full significance of this lofty conception of woman and of her place in life; with them Love was nothing but the spontaneous homage of strength to beauty; they introduced new social usages and a more elevated system of ethics among the inhabitants of southern Europe, and, at the same time, communicated to them that reverential respect which raises woman, though naturally weak, above the common level of humanity.

These are the views we find embodied in the songs

of the Troubadours, who, by their natural disposition, succeeded in attaining to a superior degree of refinement respecting the cherished objects of chivalrous pursuit: Love, Honour, and Religious Enthusiasm.

The sentiments of the Provençal poets as regards woman are delicate and enthusiastic. In the imagination of these poets, women are to men superior beings; nothing, in their judgment, civilises, softens, and elevates so much as love, which is to them the principle of every kind of honour and merit, and the keynote of their poetry.

The Troubadour looked up to his mistress with deep respect; in her presence he felt timid, and hesitated to speak to her of his feelings.* Thus, Guy of Uzes says:—

> "Into my heart, if love were weak,
> But little fear would come;
> They feel not who unfaltering speak:
> The deepest love is dumb.
>
> "Of her to others 'tis my pride
> To breathe the willing song;
> But love o'erwhelms me by her side,
> And checks my trembling tongue."

The Troubadours, it is true, are fond of exaggerating both their woe and their joy, and the depth of their feelings cannot always be measured by the enthusiasm of their language. Yet, besides a great number of poems which were composed only to serve as a tribute to the then reigning fashion of gallantry, we find poems

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* The English translation given above is that of Rutherford, *The Troubadours*, p. 121.

[redacted]

of such earnestness, that we cannot doubt the truth of the sentiments they express, *e.g.* the fine poem which Pons de Capdueil, after the loss of his mistress, wrote to the memory of "her who never proved false," and in which "he renounced love for ever." And he made good his words. From that time the pleasures of this world had no more attraction for him; he took the cross and went to the Holy Land, where he died as a brave soldier in the service of his Lord and Saviour.

It would be easy to give many more similar quotations. Yet I content myself with citing the words of a poetess, Clara of Anduse*:—"Neither he who blames my love for you, nor he who forbids me to love you, is able to change my heart. There is no one, however I may hate him, whose friend I should not desire to become if he speaks well of you; but he who speaks badly of you, could in his whole life neither say nor do anything that would be agreeable to me." Such words cannot have been written for the sake of form only; they seem to me to be the most natural, and therefore loveliest, expression of a woman who well knows the depth of her feelings, which nothing in the world is able to change.

Intimately connected with this subject of their songs was another—the beauty of the outward world. Again and again they sing the loveliness of Nature, animate and inanimate, and express their joy at the return of that time when, after the trials of a long and ungenial winter, the young world clothes itself again in its fresh and luxuriant attire, when Nature, instead of

* Raynouard, *Choix*, &c., iii. 335.

fruits, yields only flowers of radiant beauty, when the fields and the woods resound with the songs of the winged inhabitants of the air, and when the nightingale streams forth her notes of highest joy and pain. Thus, Bernard de Ventadour says: — "When I see the grass and the leaves reappear, and the flowers blossom again in the fields—when I hear the nightingale raising her clear and loud voice—I am happy! I rejoice in the nightingale and the flowers; I rejoice in myself, and still more in her I love! On all sides I am surrounded and overcome with joy, but the joy of faithful love passes every other." Here, then, we see again that what appeared to them to deserve praise, and was able to inspire them with the desire of *trobar*, was Love, of which the foliage and the flowers, the azure of the heavens, the perfume of the air, and the melodious songs of the birds were only the outward symbols and expressions. Nothing else not war, morality, or even religion in their judgment furnished subjects as glorious and as elevating. With them, love not only became the symbol of all life's joy, but grew into a kind of religion, it had its own ritual, its lessons, and hymns; and an accurate knowledge of Love's ceremonies, which were reduced, like those of chivalry, to a sort of code, became part of the education of a gentleman.

Before the poet was named the knight of the lady, he had to pass through several grades. The first degree was that of *hesitating* on both sides; the second, that of *praying* on the part of the gentleman; the third, that of *listening*, on the part of the lady; and the fourth, that of *undisguised gallantry* when

ıe was allowed to take the oath to remain her faithful knight for ever.* Thus we see that love came gradually to be surrounded by a variety of restrictions and ceremonies; questions respecting love and its rules were tried with great solemnity at Courts of Love, where ladies were the judges. In this manner the sentiment of love, in course of time, lost its charm of spontaneity and freedom; it was idealised, until it became the mere shadow of a poetic dream. In consequence of this strict system of fixed and at the same time subtle conventionalities, to which the poets soon had to submit, there was no longer any room left to them for the display of any individuality as regarded passion and character. Their songs might differ in detail, but in the main they all presented the same aspect; they suffered from constant repetition and monotony; so that a comparatively small number of these love-songs would be sufficient to give us a fair idea of all.

As said above, honour and religious enthusiasm were, next to love, the main principles of chivalry. The object a true knight had to strive for was always to assist the unfortunate, to protect the feeble against brutality and injustice, to sustain the oppressed against their oppressors, to mitigate the ferocity of uncivilised warriors: in a word, to subject force to the control of humanity. These ideas we find faithfully reflected in the poems of the Troubadours, to whom personal valour shown in warlike enterprises, and untarnished honour in the intercourse with other men, appeared to deserve the highest praise and encouragement. Hence the

* T. Libert, *Histoire de la Chevalerie en France*, p. 35.

great number of fiery war-songs for which the Provençal poets have justly won so high a reputation. Sharing, moreover, the *religious* enthusiasm of their times, they considered it to be one of the first duties of man to fight for the glory, and in the name, of God; to deliver from the hands of the infidel the holy place where Christ was born, where He had suffered and died for the eternal salvation of mankind. In their songs they made use of the same arguments which the Church employed to incite the peoples to undertake a crusade. "To go to battle for God, who had given His Son for the redemption of man, was for all Christians the best means of returning love for love; to die for Him was the surest way of being rewarded with the eternal joys of Paradise, in exchange for the pains and miseries of the earth."

There is one more point to which we have to direct our attention if we wish to acquire a somewhat accurate idea of the poetic character of Provençal poetry. Not only for their knowledge of all the niceties in the theory and practice of love and gallantry were the Troubadours remarkable, but their influence extended also to the religious and social life of their times. Making allowance for the exaggerations to which personal antipathy or personal predilection sometimes misled the judgment of the Troubadours, their poems present us with a true picture of the existing state of society, and enable us rightly to judge the times in which they lived. It is, perhaps, not too much to say that the chief importance of the Troubadours lies in those satirical writings known by the name of *sirventes*, in which we see scourged the vices of their

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contemporaries: ambition, avarice, every kind of wrong and violence, calumny, untruth—in fact, any word or deed that was in opposition to the ideal of a noble and generous knight.

They also attacked the several classes of society; none were secure from their scorn and their vituperation.

Bertrand de Born, for instance, more than once attacks with passionate violence the peasants, whom he charges with idleness and insolence towards their superiors; other poets blame the pride, the selfishness of the rich, the rapacity of the nobles; nor do they spare even princes and powerful kings. But, above all, the Troubadours raised their voice against the vices of the priests, and, in general, attacked the representatives of those institutions which in those times were all-powerful—the Papacy and the Church. "The Church," we read in one of the *sirventes*, "deceives mankind in spite of the most sacred laws, and grants indulgences for every kind of crime at a very low price; the priests themselves are nothing more than liars, traitors, perjurers, thieves, and usurers."

The extreme frankness with which the Troubadours expressed themselves is, indeed, very remarkable; the *sirventes*, in which there breathes a fresh spirit of liberty and independence, were for those times what a free press and a strong public opinion are in our own age; they really represent a moral force not a little feared by the proud barons and the insolent dignitaries of the Church. We may fitly consider Peire Cardenal as the master in the art of writing *sirventes;* he never tired of publicly exposing human frailties; his poems

show him throughout as a man of great honour and possessed of a noble and upright character. "I have always detested," he says in one of his *sirventes*, "falsehood and deceit; as my guides I have ever taken justice and truth, and I think little of the consequences this may have, for I shall not hesitate to consider as good whatever may happen to me in consequence of it." And in another passage we read: "How can we listen to the words of a reasonable being, if we know that what he says is wrong? As we are able to judge of a tree by its fruit, and of a rose by its perfume, even without seeing them, so we know that a man's heart is base and false by an untruth he tells us."

In the various kingdoms built up on the ruins of the Roman Empire there were, as with the Greeks and the Romans, wandering artists, who, on festive days and on occasions of public rejoicings, amused the people by their tricks and juggleries. The Greeks had called them *θαυματοποιοί*, *i. e.* makers of prodigies; the Romans, *scurræ*, *mimi*, *joculatores*, as their art chiefly consisted in manual or other bodily exercises, in tricks of force or agility. The Provençals gave them the name of *joglars*, the French that of *jongleurs*.

With the developement in the South of France of chivalry and of a more refined state of society, the nobles and the great barons of Provence longed for a more intellectual kind of entertainment. As with the northern Teutonic nations it had been the custom that, at public festivals, a poet rose and praised in song the high deeds of their forefathers; thus the Provençals

thought of praising what then filled the minds of all: woman, personal valour in warlike enterprises, the beauties and wonders of creation. Princes, counts and barons, vied with each other in the noble art of *trobar*, *i. e.* of *finding* verses. Hence they were called *Trobaire*, *Trobadors*, or *Troubadours*. The first Troubadour in the list of those who have transmitted to our times any remnants of their compositions is Guilhem IX., Count of Poitiers 1076. His poems show already so much artistic developement, that they necessarily lead to the conclusion that this was not the actual beginning of Provençal poetry, although his songs are the first specimens of Provençal lyric poetry that have been handed down to us. The perfection of both substance and form shown in the songs of Guilhem can only be explained by the fact that numerous poetical attempts, which have been lost, must have been made before him.

From this time forward we see for nearly 250 years a wonderful activity displayed by the Troubadours,* of whom we have to distinguish two classes: firstly, the independent nobles and princes (who composed not for any pecuniary advantage, but because they took pleasure in this poetical and refined pastime), and secondly, those poets who, like the German *minnesänger*, made a profession of the art of *trobar*, and for whom this art was a means of gaining their livelihood.

Many of these Troubadours used to go from town to

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* Although a great number of manuscripts have been lost in the course of centuries, we know of the existence of nearly 400 Troubadours. See Mahn, *Biographien der Troubadours*, p. iv. Paul Meyer, *Salut d'amour*, p. 5.

town, from castle to castle, and wherever they came they were sure to meet with a hearty welcome. The Troubadour did not always sing his poems himself; he was often accompanied by a jongleur, whose office it was to sing and to accompany on a musical instrument the poems composed by his master.

Wherever the Troubadours came, they used their influence to encourage the institution of those tribunals known by the name of Courts of Love,* in which ladies had to decide on the superiority of rival poets in their debates on questions of love and gallantry. Judgment was in most cases given by them according to the laws laid down in the Code of Love, the rules of which were followed out with scrupulous fidelity. Their decisions were final and without appeal; they punished the infidelity and treachery of lovers by the expulsion of the culprit from the society to which they belonged, and held that a true and gallant knight ought religiously to keep a promise he had once given—that he ought to consider affection the reward of personal worth only, and constancy one of the first commandments of chivalry.

In what esteem the Provençal poets were held in the Middle Ages is seen from the fact that kings and emperors—among whom it is only necessary to mention Frederic II. of Germany, Richard I. of England, Alfonso II. of Aragon, and Alfonso X. of Castile—thought it an honour to receive them at their courts.

* Raynouard, *Choix des Troub.*, vol. ii. p. lxxx. Rutherford, *The Troubadours*, p. 86 sq.

The number of different kinds of poetic compositions* of which the Troubadours made use, is very great indeed. All their lyric poems may be divided into *Love-songs*, *Sirventes*, and *Tensons*. The conclusion of the first of these species of compositions was generally an *Envoy*, remarkable for both the form of expression and the turn of thought. In the *Envoy* the poet suddenly breaks off his train of narrative or reflexion in order to apostrophise himself, his song, the jongleur who was to sing it, the lady for whom it was composed, or the messenger who was to take it to her. The *Sirventes*, comprising all those compositions not treating of love, may be subdivided into the political, moral, and personal.

The *Tenson* (from the Latin con-*tension*-em) was a dialogue between two poets, who, holding different views on subtle questions of chivalry, of love or gallantry, previously agreed upon, answered in several stanzas, of which the metre and the rhymes had to be similar. The following are, for instance, some of the questions proposed in the tenson: "Is it better to be loved and die immediately afterwards, or to enjoy long life without passing beyond hope?" or: "There are two married men; one has a wife who is handsome but disagreeable, and the other a wife who is amiable but ugly. Both are jealous; which of the two is the greater fool?" To the question, "Should a lover, who sees

* For fuller information on this subject see Diez, *Poesie der Troubadours*, p. 95 sq. Fauriel, *l. c.*, vol. ii.; Ideler, *Altfranz. Nationalliteratur*, p. 55 sq. Bartsch, *Reimkunst der Troub. in Lemcke's Jahrbuch*, i. p. 171 sq. Rutherford, *l. c.*, p. 110 sq.

his cherished mistress expire before his face, die with her or survive?" Sordel replied, "that it was better for the lover to follow her to the tomb than to survive her in agony and despair." But the other disputant was of a different opinion, holding that "the dead could gain nothing by the sacrifice of the living, and that it could not be right to do that from which no good, but much evil, would be the result." It so happened that Guilhem de la Tor, who gave the latter answer, lost his beautiful and dearly-beloved mistress: he was inconsolable, and, contradicting by his conduct the arguments he had once held and defended, he gave himself up to despair, so that soon after he followed her to the grave.*

Upon the whole there were no less than thirty different lyric kinds of poetry in use with the Troubadours: the *Pastourella*, *Alba* (morning-song), *Serena* (evening-song), *Ballada*, *Sonnet*, *Sextine*, *Retroensa*, &c. If we further mention other kinds of composition, as the *Tezaur d'Ensenhamen* (a kind of encyclopædia), the *Novellaire* (narrations in verse), some epic works of importance, and even some historical dramas, it will be obvious that the Troubadours displayed an extraordinary poetical and intellectual activity.

Even a brief survey of the literature of the Troubadours like the present would be incomplete if no mention were made of their system of versification, which surpasses that of any literature of modern Europe as regards variety, subtlety, and difficulty. By their fortunate attempts to overcome these difficulties, the Provençal poets succeeded in rendering their language

* Rutherford, *u. s.*, p. 45 sq.

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rich in harmonious and poetic expressions. They, too, carried further than the poets of other nations a predilection for rhyme; unfortunately they used, and, it must be admitted, abused, its effect on the ear to such an extent, that the idea in their poems not unfrequently suffers from too much attention being paid to form.

Each poem is generally divided into stanzas; each stanza consists of a number of verses, varying from five to twelve. The number of syllables in each verse also shows a great variety, as there are verses of from two to twelve syllables. What especially makes the Provençal language apt for versification is its extraordinarily great number of homonyms and double forms. There are, *e.g.*, not less than six different forms to express the third person singular of the preterite *he was:* fo, fon, fom, foc, fonc, font. Of these, *foc* and *fon* are at the same time substantives—the former meaning *fire*, the latter *source.* Thus the parts of speech have often more than one, sometimes three or four different forms, to express the same idea.

Provençal poetry, born and cultivated in a comparatively small country,* that lay like a fresh and peaceful island in the midst of the agitated waves of Western Europe, extended far beyond its limits a powerful influence on the poetical developement of other nations.†

* Yet this country, it must be borne in mind, was not only the present province of Provence; it extended at the time of the Troubadours from the Alps to the ocean, and from the Loire to the Pyrenees.

† See besides Diez, Fauriel and Ideler, Baret, *Les Troubadours et leur influence sur la littérature du midi de l'Europe;* Rutherford, *u. s.*, p. 333 sq.

The Italian language borrowed from the Provençal not only ideas and poetic images, but also a great number of words and whole phrases and idioms.* Nearly all the older Italian poets understood the Provençal language; many even preferred it to their own. Guido Guinicelli is among the first who introduced on the continent of Italy the taste for Provençal poetry, which was afterwards so highly esteemed even by Dante and Petrarca. The well-known Sonnet of the last-named poet, *Se l'Amor non è che dunque è quel ch' i sento?* is an almost literal translation of a poem of Jordi's. To a canzon attributed to Giraud de Borneil, beginning with the line,

> 'Ben aja 'l temps, e 'l jorn, e 'l an, e 'l mes! †
> (Blessed be the season, the day, the year, the month!)

Petrarca is indebted to a great extent for his 57th Sonnet, beginning,

> Benedetto sia 'l giorno, e 'l mese, e 'l anno
> (Blessed be the day, the month, the year!) ‡

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* From that source spring, for instance, the Italian words, *aita*, *apparecchiare*, *acquistar*, *dottanza*, *io amo meglio* (for *io voglio più tosto*). See the long list of such words given by Ruth, *Geschichte der Italienischen Poesie*, vol. i. p. 175 sq. It has even been said that the Sicilian dialect was only a more polished kind of Provençal. See Gravina, *Ragion Poetica*, ii. cap. 7.

† Rutherford (*u. s.*, p. 350) has, *ben ai al temps, el jorn*, &c. It seems to me that we ought to write, *ben aja 'l temps* = well be it with the time; *wohl ergehe es der Zeit*. *Aja* is the subj. present of *aver*.

‡ Compare with this Byron's *Don Juan*, iii. 102:

> "Ave, Maria! blessed be the hour!
> The time, the clime, the spot, where I so oft
> Have felt that moment in its fullest power
> Sink o'er the earth so beautiful and soft."

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In his *De vulgari eloquio*, Dante speaks more than once in high terms of the Troubadours, and gives the palm of poetry to Arn. Daniel, Folquet de Marseille, and A. de Puyguilhem, for having best succeeded in the canzon, and in the *Purgatorio* * he says that, "as to songs of love and romances written in prose, Arnaud Daniel surpasses all the other poets." At the splendid court of Azzo VII., of Este, 1215–1264, we find a great number of Italian poets,† who wrote in Provençal as successfully as the Troubadours themselves: this was also the case with the poets of Spain,‡ especially in the two provinces of Catalonia and Aragon.

It is a fact too well known, as to deserve more than a passing notice, that the German Minnesänger not only imitated but very often merely translated the poems of the French and Provençal poets.§

Although the language of Provence was not spoken in the North of France, yet its poetry served to a large degree as a model for the French "Trouvères," as regards both substance and form.‖

Several reasons may be given to account for the almost sudden decline of the Provençal poetry. Firstly, the rapid rise and developement of French lyric poetry, which, having originally been a national growth, inde-

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* See *Purgator.* xxvi. 118–120: *versi d'amore e prose di romanzi soverchiò tutti.*

† Muratori (*Antich. Est.* ii. 2); Ruth, *l. c.*, i. p. 147 sq.

‡ Baret, *l. c.*, p. 85 sq.

§ See Wackernagel, *Altfranzös. Lieder u. Leiche*, Kap. iv. v.

‖ Thus, "*ne pouvoir mais*," "*n'avoir que faire*," "*passer le pas*," &c., are expressions directly borrowed from the Provençal. See Raynouard, *Gramm.* ch. vii. pp. 337–342; Ideler, *Altfrz. Nationall.* p. 53, 54.

pendent of any other, from the end of the twelfth century took for its model Provençal song, which it imitated, until, from a *popular*, it became a *courtly*, poetry, and, as it were, a mere reflexion and repetition of its southern neighbour.*

As a second cause, must be mentioned the crusade of orthodox Northern against freethinking Southern France. In 1208 Pope Innocent III. preached the crusade against the Albigenses. Count Simon of Montfort led the host of armed persecutors, inciting them with the words, "Tuez-les, tuez-les tous, Dieu reconnaîtra les siens."† Thus religious fury and the horrors of inquisitorial vengeance desolated that beautiful part of France which had hitherto been the favourite land of the Muses: "the singing of the pleasure-loving Provençals was turned into mourning, their dancing into death, and all their pleasant places into a desolation."

To these two external causes must be added a third, which has often been overlooked, although it is perhaps the most important of all. Provençal poetry was a Court poetry; it was the result and outward manifestation of the chivalrous spirit of the time. When the character of the times changed,—when chivalry, no longer ennobled by the religious enthusiasm of the eleventh and twelfth centuries, lost its original splendour, Provençal literature partook of this degeneracy; the "gaie science," the merry science, rose and fell with

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* Raynouard, *Gramm.* vii. p. 337. *Journal des Savants*, 1833, p. 392. Diez, *Poesie*, &c., pp. 245, 247. Wackernagel, *Altfrz. Lieder*, &c., p. 169 sq. 188. Le Grand, *Fabliaux*, vol. iii. p. 168.

† Mandet, *Hist. de la langue romane*, p. 259.

the peculiar kind of civilisation which it had served to express.* In the period of its decline it localises itself in a certain number of centres, of which the most brilliant were the courts of Alfonso X. of Castile, of the Dukes of Este, and of Kings James I. and Peter III. of Aragon.† These centres become more and more isolated from each other, their influence grows weaker and weaker; at last they disappear. Thus comes to an end a kind of poetry, which, as to form, no longer distinguished itself except by a studied and affected elegance, and which, as to its matter, merely served as a convenient vehicle for the poets' ideas on philosophy, religion, and politics.

In conclusion, it may be observed with regard to the ancient Provençal poets, that, upon the whole and independently of their literary merit, the Troubadours exercised a beneficial influence on the spirit of their times in softening, refining, and elevating the manners, often only too rude, of their contemporaries. However, it must be admitted that they failed to attain to the highest point of moral perfection: self-sacrifice and abnegation were virtues unknown to them, nor did they ever teach the duty of doing good for its own sake.

II.

The taste for poetic pastimes was too deeply rooted in the minds of the people of Provence to allow them to live only upon the traditions of their glorious past.

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* Diez, *Poesie der Troub.*, p. 63.

† P. Meyer, *Les derniers Troubadours de la Provence*, in the *Bibl. de l'École des Chartes*, 6ᵉ *série*, v. p. 245.

In the first quarter of the fourteenth century an attempt was made to revive the old poetry. Seven citizens of the town of Toulouse constituted themselves into the "très-gaie compagnie des Troubadours,"* and "wished greeting and an ever happy life to their honourable and valiant friends and comrades, to whom *knowledge* is given." They invited them to assemble henceforth every year on the first Sunday in May for the purpose of *disputing* a violet of gold, which would be given as a reward for the best song.

The first meeting of the "very gay" Troubadours took place in 1323, in a garden of the Rue des Augustins at Toulouse. Three flowers were given as prizes: a golden violet for the best song; a silver marigold (*souci*) † for the best *ballata;* a silver eglantine (wild rose) for the best *sirventes* or *pastourelle.* The spirit of this new kind of poetry was very different from that which had preceded it; love, profane love, is no longer made the keynote of Provençal poetry, nor do we hear any more of war-songs. The holy Virgin and moral abstractions are the two subjects which the poets chiefly think worthy of their praise.

As the whole movement was not a spontaneous but

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* "Als onorables e als pros
Senhors amichs e companhos
Als quals es donat lo sabers,
La sobregaya companhia
Dels set trobadors de Tolosa
Salut e mes vida joyosa."

† The name of this flower has nothing in common with the word *souci*, care. It is the abbreviation of *soucicle* or *solacle*, which latter form is derived from *solis circulus* or *cyclus*, by which were meant the white leaves which like sun-rays radiated from the yellow edge.

an artificial one, it again and again required artificial means to sustain it. Thus Dame Clémence Isaure is said to have, in the fifteenth century, saved Provençal poetry from falling into disuse. She gave a fresh impulse to the Floral Games, as those meetings were then called. Yet, curiously enough, the very existence of Clémence Isaure, who by her poems earned for herself the surname of the Sappho of Toulouse, and who is said to have left, at her death, part of her fortune for the furtherance of the Floral Games, has been disputed. Her claim to existence was first called in question by Catel, in his *Mémoires sur l'histoire du Languedoc;* and, after the researches of Noulet* and of Cambouliu,† we cannot but regard her as not less apocryphal than Clotilde de Surville. The very texts which were formerly cited as proofs for the existence of Clémence, tend to prove that the poets simply addressed themselves to the Holy Virgin.‡

A new change took place in 1694, when the College of Floral Games was changed into an *Academy*, consisting of forty judges, who were all named by the king. This Academy was altogether suppressed in 1790, and about the same time the leaders of the French Revolution thought of suppressing the numerous Provençal

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* J. B. Noulet, *De Dame Clémence Isaure substituée à Notre Dame la Vierge Marie comme patronne des Jeux Littéraires de Toulouse.* See also *Mémoires de l'Académie des Sciences de Toulouse*, 4ᵉ *série*, t. ii. p. 191.

† Cambouliu in *Lemcke's Jahrbuch*, 1861, pp. 125–146.

‡ Mary-Lafon, *Tableau historique et littéraire de la langue parlée dans le midi de la France.* Champollion-Figéac, *Charte de commune en langue romane*, &c., p. 11. A. Fuchs, *Ueber die sogenannten unregelmässigen Zeitwörter*, p. 167. Noulet, *Essai sur l'histoire littéraire des patois du midi de la France aux* XVIᵉ *et* XVIIᵉ *siècles.*

dialects which, since the Middle Ages, still flourished in the South of France, because they considered them as a serious obstacle to a thorough and complete unification of the French nation. On the 8th Pluviose of the year II. (27th of January 1794), the French Assembly decided, on the motion of Barrère,* to secure the predominance of the French language by the appointment of French teachers in all the principal schools of France. It is perhaps not superfluous to add that this decree was directed against the other languages spoken on the soil of France (Breton, Basque, Italian, German), as much as against the Provençal.

III.

Thus, from the fourteenth century to our modern times, attempts had been made again and again by the poets of Provence to prove practically that they were not unworthy successors of the famous Troubadours.† Yet their zeal and their activity could not compensate for their want of genius; all their efforts were insufficient to carry the renown of the poetry of Provence over its own frontiers. It is not before the first quarter of the nineteenth century that we are able to detect again any traces of a truly poetic movement—of a literary activity which well deserved the name of *popular* poetry.‡

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* Wachsmuth, *Revolutionsgeschichte, Anhang.* Nodier, *Comment les patois furent détruits en France.* (This essay will be found in the *Bulletin du bibliophile*, N. xiv., p. 148.)

† E. Boehmer, *Die Provenzalische Poesie der Gegenwart*, Halle, 1870. Girein, *Les Français du nord et du midi*, Paris, 1868.

‡ The Provençal language was once very aptly compared by Jasmin to one of those ancient elms which adorn the promenade

It was a curious coincidence that at the time when the publication of Raynouard's first works on Ancient Provençal Poetry (works of which the significance was at once recognised) rescued from the dust of the past a literature almost altogether forgotten, this very language and literature should show the first sign of a reawakening of poetic inspirations. It was the beginning of that movement of ideas which manifested itself about 1820, and which Saint-René Taillandier hailed in these terms: "Unexpected as it is, it well deserves to fix the attention of the clear-sighted: from one end of Europe to the other national traditions are revived, local influences again assert their power; many effaced recollections are recalled to life; many a language that was thought dead has been found again, it seems, almost by a miracle." *

The first poet of any note who opened this poetic movement, and who may be considered as the forerunner of the *Felibre* was Jacques Jasmin, or in Provençal, Jacquou Jansemin, the Provençal Burns. Born

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of his native town Agen: "A strong wind rises and casts down several of its finest branches; workmen are sent to dig the tree out, but their pickaxes are powerless against its strong roots; the men grow tired of their work and leave the tree. But with the return of summer in the following year the branches of the elm-tree, against all expectation, clothe themselves anew in fresh and beautiful foliage, and the birds sweetly sing in its branches: men rejoice to see that its root has proved so hard and so strong. Thus it has been with the Provençal language; many storms have passed over it, and once it even seemed to be on the brink of death; but now a revival has come for it; again it begins to flourish and to blossom, nay, it has already borne sweet and delicious fruit."

* See the Introduction to *Li Provençalo*, poems collected by Roumanille.

in 1798, at Agen, in the Gascoigne, he showed at a very early age a natural aptitude for poetry. In order to gain his livelihood he was obliged to submit to some kind of manual labour. He chose as his vocation the art of a hairdresser, because, as he said, pen and comb agreed well together, inasmuch as both the poet and the hairdresser had to do headwork. His first collection of poems he called *Las Papillotos*, adding that if the pages covered with his poems were bad, they might at least be used as papillotos, *i. e.* hair-rollers.* Careless of fame and of worldly distinctions, he poured out his thoughts as naturally and unaffectedly as they suggested themselves to him. The poem by which he is probably best known to English readers is his beautiful song of *The Blind Girl* (translated by Longfellow).

The fame of the new Provençal poet soon passed the narrow borders of Provence. While the Parisian public listened to his songs in wonder and delight, the first literary critics of the country bestowed on them high and unqualified praise. Sainte Beuve called their author the *Manzoni languedocien*, Villemain extolled him as the *poète moral et populaire*, and the French Academy accorded to him the first prize and a medal of honour.†

* I am reminded by a learned friend of Congreve's lady's maid, who liked her mistress to pin her hair up with poetry—"it sits so pleasant." (See *The Way of the World*.) Jasmin's other conceit, too, has a parallel in that of Allan Ramsay wigmaker and barber, as well as bookseller and poet—who wrote of himself:—

"I theek the out, and line the inside
O' mony a douse and witty pash."

† See the interesting account of this poet's life and works in L. Stuart Costello's *Bearn and the Pyrenees*.

The last notes of his song had scarcely died away when a greater poet than he appeared, in the son of a gardener of St. Rémy—*Jos. Roumanille.* On leaving school he wrote some French verses, which he destined for his mother. But reading them to her one evening, he saw that she did not understand them; what little French she had once learned at school she had forgotten long ago. In his disappointment, young Roumanille, regretting that his mother was unable to enjoy, and to be refreshed by, noble and generous thoughts clothed in the harmonious form of poetry, was led to inquire more fully into the actual state of Provençal poetry and language. Thus he came to see that, properly speaking, there was no longer in Provence what deserved the name of a literature; nor could there be any, since for centuries the Provençal language had been neglected and despised, or dishonoured by low and vulgar songs of the street and of public-houses. For these he proposed to himself to substitute a healthy, honest, and truly popular poetry.

Roumanille remained faithful to his intention. He published in 1847 a first collection of poems under the name of *Li Margarideto* (*the Daisies*), in all of which there reigns a pure and healthy tone; we feel throughout that the principal object to which he aspires is the moral education of the people. His endeavours were soon crowned with success. The *Daisies* quickly spread over the country and inspired others with the desire to follow in their author's footsteps, so that in 1854 Roumanille, with the aid of a certain number of his friends

and disciples, was able to found the society of the "Felibres."*

The object which the Felibres set before them has been well defined by Mistral, on the occasion of a festival which the Provençal poets gave at St. Rémy to their Catalan brethren: "We wish that our sons, instead of being brought up in the contempt of our language, should continue to speak the language of the country where they are masters, where they are proud, where they are strong and free. . . . . We wish that our people should know that their ancestors, of their own accord, annexed *themselves* to noble and generous France,—and this in a dignified manner, *i. e.* preserving their idiom, their usages, their national characteristics; we wish that our people should not forget that its language was once the poetic and literary language of Europe, the language of love, of the *gai savoir*, of civilisation, and municipal liberties."†

This object the Felibres steadily pursue in the *Armana prouvençau* (*Provençal Almanac*), published every year at Avignon, and containing, in the Provençal language, contributions, in prose and in verse, by Roumanille and his fellow-poets, of whom Mistral, after having written smaller poems such as the *Course des Taureaux*, or the *Folle Avoine* (a biting satire on

* The etymology of this word is, according to some, *qui facit libros* (*fe-libres*), or according to an old Provençal chronicle, which applied this term first to the apostles, *des hommes libres dans leur foi*. See Garcin, *Les Français du nord et du midi*, p. 453. Ch. de Tourtoulon, *Renaissance de la littérature Provençale*, p. 9.

† Ch. de Tourtoulon, *l. c.*, p. 23 s.

idleness), rose to a celebrity not previously reached by any Provençal poet of this century, by his delightful poem *Mirèio* (in French, "*Mireille*"). This elegiac poem, which appeared in 1859, contains, together with a simple but pathetic love-story, a striking picture of the Provençal people, of its occupations, its customs, its religion, and superstitions, and vividly brings before us a country renowned for the beauty of its scenery and for its manifold and highly interesting traditions of a glorious past.

In the first two cantos the chief personages of the poem are introduced to us in the following manner. Ambroise, a poor basket-maker, comes one evening with his son Vincent to the "*Mas des Micocoules*,"* the house of Ramon, a rich farmer. After the frugal evening meal, Ambroise, at the request of Ramon and his servants, relates to them an episode of the war against the English, in which he had taken a prominent part. During that time, Vincent gives to Mirèio, Ramon's daughter, who has just entered upon her sixteenth year, and whom he has known for some time past, an account of his own life, of the miracles he has witnessed, and especially of the famous festival at Nimes, where he nearly won the prize in running. "And while they were talking," continues the poet, "their heads were leaning against each other, like unto two blooming flowers which bow before a merry breeze."

"The crickets singing in the hillocks, more than once paused in order to listen; the nightingale and the

* *I.e.*, the *House of the Lotus-tree.*

night-birds in the woods kept silence; and, moved to the depth of her soul, *she*, sitting in the green arbour, was fain not to shut her eyes before the rising dawn."

"'It seems to me,' she said to her mother, 'that for a basket-maker's son he speaks wonderfully well! Oh, mother! in winter it is a pleasure to sleep, but now the night is too bright! Oh, let us listen, and always listen, to him; my evenings, nay my whole life, could I pass in hearing his tales.'"

A few days after, on a beautiful spring morning, Miréio and the young girls of the neighbourhood are occupied with gathering the leaves of the mulberry-trees. Miréio, who according to custom has seated herself on one of the branches, sees Vincent pass by and asks him to help her. Vincent gladly obeys, and sits down at her side on the same branch. Time passes on; they scarcely become aware of it, because they are too busily engaged in talk. At last, their attention is directed to a nest of little birds; both lean forward to admire them, when, lo! the bough on which they are seated suddenly breaks. Vincent has just time and presence of mind enough to take her in his strong arm. The short moment during which he has felt her head repose on his heart is for Vincent one of inexpressible happiness, and which he would not forget in all his life. Full of solicitude, he asks the young girl, who has suddenly become serious and pensive, whether she has taken any hurt. "No," she answers, "although there is something that torments me and makes me uneasy."—"It is perhaps the fear of being scolded by your mother for having been so long over your work? Or, have you suffered

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from the excessive heat of the sun?"—"No, no," she replies, "it is something else that affects me, and that prevents me from hearing and seeing—Vincent, Vincent, do you want to know what it is? My heart cannot shut it up within it any longer—I love you!" This is almost too much for poor Vincent; he cannot believe it. "You, Miréio! you say you love me? In the name of God, oh, do not play with my poor, but contented life! Do not make me believe things which, once sunk into my heart, would in the end be the cause of my death! Miréio, you who are the queen of the Mas des Micocoules, do not thus laugh at me, who am but a simple basket-maker!"—"What matters it to me," she quickly replies, "whether my beloved be a baron or a basket-maker, so long as I love him!" Whereupon he bursts into the passionate words which had so long been pent up in his breast:—"Oh, I love thee, enchanting maiden, so dearly that if thou wert to say, 'I want that star yonder!' there is no sea, nor wood, nor wild torrent—there is no tormentor, nor fire, nor sword that could stop me. From the highest point of the mountains I would fetch it, and—on Sunday next I would hang it round thy neck! But the more I look at thee, the more I am dazzled; on my way I once saw a fig-tree, clinging to the bare rock of the grotto of Vaucluse, poor and miserable; once a year the waters of the neighbouring well come and touch its roots; then the barren tree drinks as much as it likes, to quench its thirst, from the abundant water which ascends to it. Well, all this applies to me; for *I* am the fig-tree, and *thou* art the water and the freshness.

And would to God that, once a year, I in my poverty could, on my knees, as I do now, sun myself in the rays of thy countenance, and that, above all, I were able to breathe on thy fingers a trembling kiss!"

I have no space to give in detail the sequel of this romance, or to accompany through all her troubles Miréio, the beautiful child of sunny, passionate Provence, who, faithful to him her heart has once chosen, was not permitted to enjoy the happiness she had once dreamt of in the first days of her love. After the perusal of this poem, it is easy to understand the enthusiasm with which Lamartine* expressed his admiration for the genius and truly poetic power of Mistral:—"Thy epic poem is a masterpiece; I will say more, it is not from the Occident, it is from the Orient; we would fain imagine that an island of the Archipelago, a floating Delos, has during the night separated from its group of Greek or Ionian islands, and has come silently to unite itself with the continent of balsamic Provence, bringing with it one of those illustrious poets of the family of Melesigenes. Be welcome to the poets of this country! Although belonging to another climate and to another language, thou hast brought with thee thy climate, thy language, and thy sky! We ask neither whence thou comest nor who thou art: 'Tu Marcellus eris!'"

Roumanille's and Mistral's example has already borne its fruit. Numerous poets have arisen, among whom stand foremost Aubanel, Mathieu and Tavan,

* Lamartine, *Cours familier de littérature*, 40e entretien, p. 233–313.

who all vie with each other to win glory and renown for their country.

The revival of Provençal language and literature is not generally approved of by French critics,* because this literary movement seems to them to interfere with the diffusion of the French language; to tend to the formation of a Provençal, as opposed to French, nationality; and to be the first step towards the decentralisation of the whole country. In a word, the charge preferred against the modern Provençal poets is, that they aspire not so much to the office of simple poets as to that of political agitators. Mistral especially, the head and master of all, has been the object of severe attacks on the part of the critics, who keep repeating the question, "Why do you not write in French?" Referring our readers to Mistral's words, cited above, I add the following remark of the same author, which I find in the preface to Anselme Mathieu's *Farandoulo*, p. 18:—"The parents of Mathieu, as well as those of Roumanille and of Tavan and my own, do not understand any other language than the Provençal. And, once for all, may this serve as an answer to those who ask us, 'Why do you not speak French?'" And, indeed, Provençal is still spoken by about ten millions of people,† a far larger number than one generally

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* See G. Paris in *Lemcke's Jahrbuch*, 1861, p. 15. Saint-René Taillandier in the *Revue des deux Mondes*, 1867, p. 769. Garcin, *Les Français du nord et du midi*, p. 5.

† *Rapport sur les progrès des lettres par* MM. Sylvestre de Sacy, P. Féval, Th. Gautier et Ed. Thierry (Paris, 1868). *Armana provençau* of the year 1863, p. 29.

thinks; even among the higher classes of the South the use of the French language as the current idiom of conversation begins little more than a century or a century and a half back.* And as to Provençal poetry, the same competent judge remarks † that for the formation and expansion of an original Provençal literature there is now a greater chance of success than in the fourteenth century.

Finally, I must not forget to mention that the deep interest with which every Provençal regards the present literary movement of his native country, is powerfully aided by those poetic festivals which, recalling the Floral Games of former times, are celebrated every year in some of the larger towns of Provence. For the "Concours" at Aix in 1869, not less than eighty-four competitors entered the poetic lists, ten treating the first and most difficult subject, thirty-five the second, and thirty-nine the third. The following subjects had been proposed:—

1. *Provençal Poetry at the time of Raymond Bérengar IV. and of Béatrix of Provence* (*i.e.* that period when this country, in which both the language and the literature were still in a flourishing condition, was first overrun by the armies of Northern France).

2. *The Praise of the Olive Tree*, the national tree of the country.

3. *A Comic Poem*, the choice of which was to be left to the competitor.

One of the best poems of the third division was that

* See P. Meyer in the *Bibliothèque de l'école des chartes*, 6e série, t. v. p. 247.

† See *ibid.*, p. 248.

of M. Dapotry, who had taken as his subject, "A scholar* who did not know enough," and who was rewarded by an "honourable mention" for the very felicitous and spirited manner in which he had treated it. "A master of a small college, more a pedant than really a scholar, one day crossed the Rhone in a small boat, rowed by a simple boatman. The pedant asks him, 'Do you know philosophy?'—'That must be an island very far from here, because I cannot at all tell you where it is.'—'I pity you, my friend,' says the scholar, 'for one of the four parts of your life is lost. But, at least, you know geology?'—'I suppose you are speaking of a country that is not French; how can you expect me to know an island lost at the end of the seas!' Laughing at this ignorance, the scholar resumes: 'Believe me, my good man, you are to be pitied, for the half of your life is lost. But you certainly know astronomy, do you not?' The boatman has never heard of it either, whereupon the scholar indignantly says to him, 'My good man, through your great ignorance you have lost three-fourths of your life; I pity you indeed.'. Scarcely has he finished these words when a sudden gust of wind upsets the boat. The learned man raises a loud and pitiful outcry, whilst the boatman, safely swimming to the shore, quietly asks him, 'Do you know how to swim?' 'No,' replies the other, in a voice scarcely audible; 'I never learned the art of swimming.' 'Then you are indeed to be pitied, for certainly *all* your life is lost.'"

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* *Un savènt que n'en saup pas proun.*

These poetic pastimes of the South, recurring at certain intervals, tend very much to awaken, to strengthen, and to intensify the love of Provençal song. One particular feature in them is that now, as in the times of chivalrous poetry long gone by, true poetry is to the Provençals inseparable from woman and moral perfection; in praising and elevating the former, they pay homage to the latter. Let us, for instance, listen to the opening words with which M. Bonafous greeted those who had come to witness the distribution of prizes at the Concours de Poésie Provençale, held at Aix in 1869. "It is for the third time," he said, "that the town of Aix celebrates the festival of Provençal Poetry, and that she invites the friends of the *Gai Saber* to take part in these jousts, which recall our ancient Courts of Love. The illusion is complete. To-day, as then, the ladies of our town, embellished by our sun and sweeter than the perfumes of our hills, have come to applaud the triumph of the victors, to listen once more to the sweet melody of our mother tongue, and to give to Poetry what is of greater value than our medals and our praises, viz. the gracious smile of beauty.

"Be welcome, ladies! Without you, what would become of poetry! And what would human life be without you, who spread everywhere consolation and happiness; you whose caresses cheer up the child that weeps at the gates of life; you who make order and peace reign at our hearths, and who uphold the courage of man in his struggles by surrounding him with the smile of your affection and with the wisdom of your advice. Be not only welcome, but always and

everywhere, be loved, respected, and blessed! Poetry resounds in our hearts like a lyre of gold, and awakens there noble desires and generous thoughts; Poetry makes us forget for a moment the bitterness of misfortune and the passions of politics; without her, life is dark and heavy; with her, and around her, everything reflects joy, because she carries us from the sadness of reality to the splendid regions of Imagination and Hope!"

To conclude, then, it may be expected that, whether or not the literary and poetic revival of Provençal poetry is approved of by Parisian critics, all those who, without prejudice of any kind, and standing aloof from literary party warfare, have once refreshed their minds at the pure source of modern Provençal literature, will easily understand, and readily sympathise with, the ardent wish with which M. Monné, who won the prize at the Aix festival in 1869 for the first of the three subjects proposed, concluded his poem: "Thou, sublime Poetry, who hast crowned the brow of Mistral with the most brilliant of thy rays; thou, Muse of Provençal lore, who hast seen the love of the Provence in the hearts of her poets, in the hearts of her youth,—never, never, shalt thou die."

H. BREYMANN.

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XII.*

The Judicature Act of 1873 in its Relation to the History of the Judicial System of England.

Those laymen who followed the discussions in Parliament and the press of the English Judicature Act of last Session, must have been surprised at the comparatively small interest which its most important provisions—those for the fusion of Common Law and Equity—seemed to excite among English lawyers and in the English public generally. It often happens, no doubt, that the greatest real changes, whether political, or social, or legal, are those which are least noticed at the time; but this is usually the case because they are brought about in an imperceptible or unconscious way. Here, however, a change was made of the most sweeping nature, of set purpose and after full consideration,—a reform in English law greater, in some points of view, than any we have had since English law itself began to exist; yet the bulk of the legal profession seemed to care only for some two or three points in it which directly affected their interests, and the English nation, as represented by the newspapers, scarcely took note

* Delivered as an Opening Address to the Law Courses of the College for the Session 1873-74.

of it at all. This indifference on the part of the general public can be explained only as a result of the way in which the law has been kept to them as an inscrutable mystery. Considering how thoroughly local and national English law is, how closely its developement has been bound up with that of the political constitution of the country, how trusty an ally it, and, on the whole, the profession which practises it, have proved of our civic liberties, how large a part, owing to the jury system, the people fill in its actual working, how much its Courts are respected, how fully their proceedings are reported, one might have expected an interest in their law and a knowledge of its condition and prospects to be widely diffused among Englishmen. So far is this from being the case that there is probably not a country in Europe where the ordinary citizen has so little idea of the nature of the rules he lives under and so little power of forming an opinion on changes proposed in them, where in private affairs he is so completely at the mercy of his attorney and counsel, and in Parliamentary discussions so wholly dependent on the wisdom or unwisdom of those who happen to have seats in either House.

But the indifference of the public to the Judicature Bill was scarcely more noticeable than the indifference of the profession. Hardly anybody showed, I will not say enthusiasm or hostility, but even, a reasonable degree of interest in it on the ground that it was effecting an extraordinary and complete revolution in our judicial machinery, one which carried us back to the very foundation of the whole system, and which was in one sense a completion, in another a

reversal, of the series of changes and modifications which had been in progress ever since the twelfth century. No existing political institution, except indeed the Papacy, has so great claims on the attention of the historical student as the Constitution of England, for none represents so long, so complicated, and so instructive a process of developement—none has so perfectly succeeded in preserving its general character unchanged, while admitting the endless alterations in detail which were needed to accommodate it to the changing needs of the times. Of this Constitution, that of the English Law Courts is an essential, and not the least important or instructive part. The Judicature Act has therefore an historical importance quite apart from and beyond its practical importance to English lawyers; and it is surely desirable that this importance should be pointed out, and the attention of those who take an intelligent interest in the history of their own time be called to the nature of the change it effects and the light which that change receives from the past. One has a sort of feeling as if we were paying but scant respect to our ancestors in thinking so little of their purposes when we are thus dealing freely with their work, or as if the lofty and austere genius of English law received scarcely sufficient tribute from those who have lived under it, when so great a revolution passes almost unnoticed by the English people.

The nature of the change effected last Session cannot be understood without some little knowledge of the outlines of our judicial system as it still exists,

though now under sentence of extinction; and this, in turn, can only be explained by giving a sketch of the curious course of historical developement whereby it was moulded into its present form.

For almost all practical purposes the history of the English law and the English courts may be taken to begin with King Henry II., who is, more truly than the great Conqueror himself, the subduer and organiser of feudal England. Along with the fierce and passionate nature which he inherited from that hero, Henry had great steadiness of purpose, great consistency in his ideas, and unlimited craft and ingenuity in working them out. He is, more at least than any other single man, the founder of the judicial system which has lasted among us ever since his days, and which is to expire, or be transformed, on the 2nd of November, 1874.

Now, in Henry's time there was an immense variety of jurisdictions in England, though all, of course, working very irregularly, and almost as often the instruments of injustice as of right. There were the old shire moots, or county courts, and the courts of the hundreds, which had descended from Anglo Saxon times. There were the feudal courts of the barons, attended by their vassals; the manor courts, the courts leet, and so forth—some of which still survive, though rather as legal curiosities and modes of effecting conveyances than as courts of jurisdiction. There were already a few burgh courts in some of the towns. There were the ecclesiastical courts, those of the archbishop, bishop, and archdeacon, exercising in those days a wide and important jurisdiction over laity (though as yet chiefly in

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spiritual causes) as well as clergy. And lastly, there was the King's Court, out of which our great modern superior courts have grown, and of whose history I shall attempt to give a brief outline.

In every Teutonic kingdom the custom was for the king to decide upon all matters of consequence in the midst and with the advice of the great men of the realm, barons and prelates, whom he summoned from time to time for the purpose. From among them he chose, almost invariably, his chief ministers, such as the Justiciar and the Chancellor, and some of the ministers of lower rank were naturally also present in the council to hear what passed and give their advice to their master. Such a council was that of the Saxon Witan, or Witena-Gemot—the Assembly or Meeting of the Wise—and this Great Council, as it was called, which surrounded our Norman kings here, as a similar one had surrounded the Duke of Normandy at Rouen, was practically the successor and representative of the Witena-Gemot of ancient England. It was summoned usually twice or thrice a year, and oftener if any need arose; and had, like all primitive assemblies, judicial as well as legislative and administrative functions, the King sitting to hear and decide causes of great moment, with the advice of the assembled barons and bishops. But as it was unwieldly, owing to its numbers, and met only occasionally, all the ordinary business soon came to be despatched in a smaller body, which sat constantly, following the King from place to place, and in which the immense majority of suits coming under the notice of the Crown were dealt with. This smaller body

consisted of the Justiciar and possibly some of the other great ministers of State, a few personal friends and advisers of the King holding an almost official position, and several subordinate officers charged with the details of administrative and judicial business. It is commonly called the Curia Regis or King's Court, sometimes, at a later period, the Lesser Council, to distinguish it from the Great Council, and is the germ both of the Privy Council and of all the law courts, as the Great Council is the original form of the Parliament of England.

When Henry II. was reorganising the government of the country after the disorders of Stephen's reign, he established this Curia Regis on a permanent footing, regulating its procedure, and creating, or at least remodelling (for our information on the point is but scanty) what may be called two permanent committees, while at the same time he encouraged the Curia, as a whole, to begin a career of aggression—but of necessary and beneficial aggression—upon the various local and feudal courts, by withdrawing lawsuits from their cognisance, and undertaking itself to decide them. One of these committees, that to which belonged the management of the revenue, with such judicial duties as were naturally connected therewith, had existed in a tolerably perfect form since the days of his grandfather, but the other, that to which he allotted the more purely judicial business, seems to have received from him its first organisation and its regular limited staff. The members of this judicial committee began to be called Judges or Justices of the Bench, while those of the revenue committee, which met "*ad scaccarium*"

retained the older title of Barons (whence we still say "Barons of the Exchequer"); and by regularly sending some of them through the country to collect various feudal dues owed to the King and decide certain classes of causes, Henry refounded, or at least resettled in a lasting form, the system of circuits, and extended the authority of the Crown's writ over the remoter parts of his dominions. By the end of his reign, therefore, we may say that these committees of the Lesser Council—itself a sort of standing committee of the Great Council—had assumed the form of regular courts of law, and we soon begin to hear them called by the familiar names of the Bench or the King's Bench, when sitting to try matters where the Crown was concerned, and of the Exchequer. This latter, however, was still quite as much a revenue office as a court, and each court had not yet received a separate and permanent staff of judges. Meanwhile the body which had been the full Curia Regis or, as it is henceforth usually called, the Ordinary Council, continued to subsist apart from, and above, these committees, dealing with matters of greater consequence, and interfering in cases where the committees had not done, perhaps felt themselves too weak to do, complete justice; and at the same time the Magnum Concilium of the whole nation at its less frequent meetings considered cases of still greater moment, brought before it either by the King or by some petition from a subject addressed to him in his Great Council.

This is the first stage in the history of our courts, and as compared with the previous confusion, it represents a very great and valuable advance. Its comple-

tion is marked by Henry's definite re-constitution in 1178 of the judicial committee of the Bench,* reserving graver causes for his own hearing in the Curia. A further point is marked by the provision in Magna Charta, twenty years later, that "Common pleas should not follow the King, but be held in some fixed place." Common pleas were suits where the parties were subjects (as opposed to Crown pleas, where the Sovereign is a party), which it was, of course, inconvenient to have tried now in one part of the country, now in another, wherever the King's pleasure or his military duties carried him. And the fixed place was Westminster, where from that time till this the Court of Common Pleas, thus separated and now receiving its own permanent judicial staff, has always sat. The Exchequer also, which had by this time ripened into a regular court, became settled there; but the Queen's Bench, although for many centuries it too has sat in or beneath the shadow of that magnificent hall of William Rufus, which may well be thought the chief glory of English architecture, can still in theory sit wherever the Crown is present, being the very Court of the Sovereign himself, although the Sovereign may not personally appear in it.

It is not necessary, for the present purpose, to pursue the subsequent history of these three great superior courts of Common Law—Queen's Bench, Common Pleas, and Exchequer—which thus grew out of Henry II.'s arrangements for the business of the Lesser Council, and which had fairly taken shape, almost their

* Bened. Abbas, I. 207

modern shape, as courts of law by the time of King Edward I. But it is pertinent to remark, that while each, as it separated itself from the others, appropriated a distinct department of the jurisdiction which had belonged to the whole Curia—the Queen's Bench a jurisdiction in criminal matters and various other cases in which the Crown was concerned, the Common Pleas in actions between subject and subject, the Exchequer in revenue suits—both Queen's Bench and Exchequer afterwards encroached on their sister's province, and acquired cognisance of causes between ordinary subjects. This was done by various odd fictions. For instance, the Queen's Bench could always entertain suits against its own officers or persons in their custody. Accordingly it allowed a plaintiff bringing an action to aver that the defendant was in the custody of its marshal, and the defendant not being permitted to deny this allegation, the action went on upon the assumption that it was true, although as a matter of fact there was not the slightest foundation for it. Similarly the Court of Exchequer, having of right jurisdiction where the revenue was concerned and over the King's debtors, encouraged a plaintiff to state, in bringing his action, that he was indebted to the Treasury in a sum which he could not pay, because A B owed a certain sum to him, the plaintiff, and would not pay it, for which latter sum, therefore, he sued A B. Whereupon the court, forbidding A B to refute this figment, assumed jurisdiction in the matter, and tried the case out between the supposed debtor of the Crown and A B, the defendant. It is natural to ask why courts, whose tendency has in modern times

been rather to decline the duties the Legislature throws on them, should then have tried to increase their business? The reason is a simple one. The judges were in those days to a great extent paid by fees, and hence the old maxim, "Boni iudicis est ampliare iurisdictionem," was one which bad judges were probably quite as willing as good judges to apply in all its fulness.

These three Common Law courts, as they became permanent and independent of the King's Council, lost something of the power which had belonged to them when they were a part of the executive or administrative government of the country. Their mandates were not in the same direct sense the King's mandates: their mode of giving effect to a judgment was to command the sheriff to levy execution, and this the sheriff might not be able to do against a powerful defendant. They had, moreover, already worked out a very rigid and technical system of rules of procedure, whereby their jurisdiction was confined within definite limits, and exercised only in a certain mode, and they refused either to recognise new rights, for which some precedent could not be quoted, or to give any new sort of judgment or other relief to a complainant who asked for it. Some further judicial intervention was therefore necessary, and this was finally obtained by the developement of another branch of the Curia Regis through the action of its chief official (after an unsuccessful attempt had been made in Edward I.'s time to bring these cases into the Common Law courts). The establishment of the three Common Law courts had not, it will be remembered, superseded the legal functions of the Curia Regis in its original form, graver

questions being always reserved for that body, and petitions for redress addressed to the King in it. These petitions multiplied in cases wherein complete justice was not done by the Common Law courts, or wherein they altogether refused to interfere; and such petitions were referred by the King to the Chancellor, who was (since the extinction of the office of Great Justiciar) his chief minister of justice, the head of the whole judicial administration of the country, and the guardian of the Great Seal. The King was the fountain of justice, and he who kept the King's conscience and advised him, and held that by which his acts were authenticated, became naturally charged with the duty of seeing justice done through the King's dominions. In course of time these petitions began to be addressed to the Chancellor direct, who investigated the matter, compelling the parties to appear before him, and awarded redress, which he enforced by the direct power of the Crown. Thus at length he became a regular judge, the head of a regular court; his principal clerk, the Master of the Rolls, acquired the right of sitting in it in his room; the procedure of the court assumed a definite shape; its decisions were recorded, and a complex body of new law built up out of them. The court thus slowly developed from the fourteenth till the end of the seventeenth century is what we now call the Court of Chancery: the new body of law is Equity, as distinguished from the old Common Law. The scope and duty of this tribunal is held to be, like that of the Roman Prætor, to act *iuris civilis vel supplendi, vel corrigendi vel adiuvandi gratia*, to award relief where the older courts do not give it, to correct

and, if necessary, restrain their jurisdiction where it may produce injustice, to aid it and extend its usefulness where, from some defect of procedure or want of power, it may not be able to do complete right between the parties. In the present century the great increase of business caused by the growing population and wealth of England compelled the establishment of three additional Chancery judges of first instance, the present three Vice-Chancellors, and also of two Judges of Appeal, the Lords Justices, who sit either alone or with the Lord Chancellor. And thus out of the function of the Chancellor, as judicial minister of the King and president of the King's Council, there has been developed a second set of courts, quite independent of the older Common Law courts, a second offshoot from the Curia Regis, the source of a new jurisprudence and of a new procedure, much more flexible than that of the Common Law, and more nearly resembling that of the Roman Law and its progeny in Germany, France, and Scotland.

The Curia Regis, however, or as we may now begin to call it, the Privy Council, itself continued for two or three centuries to subsist as before, receiving certain classes of cases which were not handed over to the Chancellor's office; and a branch of it, which undertook criminal matters, acquired an infamous fame as the Court of Star Chamber. This branch was abolished by the Long Parliament, and although the Privy Council still nominally subsists as a great body in the State, its old functions have practically passed to that comparatively small committee of it, unknown to the law, but, in fact, the executive government of England,

which we call the Cabinet, and which, under our modern system, is necessarily composed of persons who are members of the Magnum Concilium also. But its jurisdiction as a court having also remained in theory, was turned to account by the erection of a new court, under the name of the Judicial Committee of the Privy Council, to which are referred appeals from India and the Colonies, as well as from the Court of Admiralty and the Archiepiscopal courts. This Judicial Committee is the third and latest offshoot from the old stem of the Curia Regis. Meanwhile the Magnum Concilium, which in the thirteenth century became, by the addition to it of the representatives of counties and boroughs, what we now call the Parliament, retained in its upper and elder branch, the House of Lords, its old jurisdiction over matters brought before the Sovereign in his Great Council. This jurisdiction became, after many struggles and controversies, restricted to appeals only, but in that respect was fully established in the seventeenth century, and the House of Lords is accordingly our Supreme Court of Appeal from all decisions either of Common Law or of Chancery courts, as well as, since the two Unions, from the Court of Session in Scotland and the Courts of Ireland.

Having mentioned Scotland, one is tempted to pause far a moment to note very briefly the causes which have given a different direction to the growth of the Scottish Courts of Law. There are many points of resemblance between their early history and that which I have been attempting to sketch. The judicial system was originally, in Scotland as in England, a department

of the royal administration, scarcely conceived of as separate from what we should now call the legislative and executive, and was conducted in the same way by the King in his Parliament and his Council, itself a kind of standing committee of the Parliament, by means of various ministers, the chief of whom were the Justiciar and the Chancellor. Some suits appear to have been determined by the *domini electi ad causas* or *domini auditores*, members of the Parliament who were chosen for the purpose, and usually met only when Parliament was in session; others by the King's Privy Council, that is, practically by some few councillors, called *domini concilii*, and appointed to this duty by the King or Chancellor; others by the Justiciar, who, like the English justices from the time of Henry II., made his circuits through Scotland as well for civil as criminal business. The civil jurisdiction of all these various persons was in A.D. 1532 transferred by James V. and his Parliament to fifteen permanent judges, forming what we now call the Court of Session. And Scotland thus received in the sixteenth century what England had obtained from Henry II. in the twelfth, a body of qualified persons set apart for the function of administering the law, and able therefore to give a definiteness both to its substance and to its procedure which had formerly been wanting, and more effectually to assail and limit the hereditary jurisdictions of the nobility. It is in the comparatively late period at which these events happened in Scotland that the explanation seems to lie of this capital difference between the fortunes of English and of Scottish law that in the latter there is no distinction of Common Law and Equity.

Equity as well as Common Law being administered by the same judges and under the same system of pleading and practice. The territorial and heritable jurisdictions of the great nobles had in Scotland been much stronger than in England, and the power of the Crown much weaker and more irregular: the judicial action of the Stuart kings, through their Council and Justiciar, was therefore much less effective than that of the English Plantagenets, and had not succeeded in building up before James V.'s time a fixed system either of rules of law or of process. There were in Scotland, prior to the Court of Session, apparently neither professional judges nor professional procurators or advocates: and without a legal profession one may say that there can be no real law. Those who sat to decide were not always the same persons, and rather did justice according to their notions of what was right and expedient than upon recognised principles. The law which was administered in the King's name was, therefore, of that comparatively indefinite and arbitrary character which the Equity administered by the Chancellor bore in England; and when the Court of Session arose it received all the wide discretion and power of developement which the English Chancery then still retained, but which the English Common Law courts had long since lost. Moreover, like the English Chancery, the Court of Session was to a great extent filled by ecclesiastics, and therefore more disposed than a lay tribunal might have been to take an equitable view of legal relations, to be guided by the more lax or liberal, and what may be called the more moral, views of men's rights and duties which were applied by the doctors of the Canon Law,

and to adopt the comparatively loose and flexible modes of procedure and copious pleadings employed in the Ecclesiastical courts; while as the Roman Law had become to a certain extent recognised as the Common Law of Scotland, Scottish judges possessed in the Digest an inexhaustible treasury of equitable doctrines, stated in the most lucid and elegant form. The Court of Session, therefore, remained at liberty to mould its rules of practice freely, to create new principles of law for itself or expand old ones; and its law did not become crystallised, so to speak, until the great work of Lord Stair in the end of the seventeenth century gave it a definite shape and arrangement. Warned or unconsciously influenced by the example of England, the Scottish Court suffered no division of jurisdictions to arise, and still retains in its own hands all the powers and remedies which south of the Tweed have become dispersed among different tribunals, as well as a certain measure of administrative or executive power exceeding that which would in England be entrusted by the Parliament to any judicial authority. Some eminent lawyers have thought that from being thus a Common Law as well as an Equity court, the Court of Session has developed equitable principles in their application to relations unknown to the Roman jurists, less fully and completely than the English Chancery has done; but even if there has been some defect in this respect, it has not been without compensation in the superior simplicity and condensation and what may be called the completer inner self-consistency of Scottish law.

Returning from this digression, it must be added that over and above this progeny of the King's feudal

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council, there were, down till the year 1857, a number of Ecclesiastical courts throughout England, in which wills were proved, from which administration of the estates of persons who had died intestate was granted, and in which matrimonial causes were heard. All these were, except for purely ecclesiastical purposes, put an end to by two Acts of that year, 20 and 21 Vict. c. 77 and c. 85, which transferred their powers to two new courts,—the Court of Probate and the Court for Divorce and Matrimonial Causes. Then there is the old court of the Lord High Admiral of England, which we now know as the High Court of Admiralty, and which administers a body of law founded in the main upon the law of Rome, though modified by the customs of maritime nations, and uses a procedure different from that of either Common Law or Equity courts. And, lastly, one may name (though as the creature of modern legislation it needs no more than a passing mention) the London Court of Bankruptcy, regulated by 32 and 33 Vict. c. 71.

We have thus at this moment in England (omitting all notice of the county courts, the local courts of record, and other miscellaneous inferior courts) four or five courts of appeal and eleven superior courts of first instance, employing three, one might perhaps say four, dissimilar systems of pleading and procedure, dealing with different classes of cases, and where they deal with the same recognising different and often opposed and inconsistent rights, and awarding different remedies. In fact, the use of the Chancery courts has been, to a great extent, that of controlling and checking the action of the courts of Common Law ; so that, as has been said,

we have allowed one court to do injustice and then set up another to stop it; or, as an eminent late Lord Chancellor used to say, a man may on one side of Westminster Hall have judgment given and execution issued in his favour, and on the other be called a fraudulent rogue, and forbidden to use the judgment he has just obtained. For about two hundred years (since the powers of the Chancery courts and the leading principles of Chancery law were not fully established till near the end of the seventeenth century) this singular system has prevailed among us—the wonder of other nations. But the last stage in its developement was not reached till about fifty years ago, when the practitioners in the Common Law and those in the Equity courts became distinct bodies, and the strange spectacle was presented of two sets of judges and counsel, each ignorant, and confessing themselves ignorant, of the rules which were administered and argued upon by the other.

The causes which produced this unexampled phenomenon have been already sketched, viz., the weakness of the old Common Law courts, arising from their early separation from the executive power, which made it necessary to supplement them by some other judicial machinery, and the stiffness of their procedure, which made it easier for the Sovereign to act in an apparently arbitrary way through the Chancellor than to attempt to remodel and extend the Common Law rules and modes of pleading and trial. It is a more difficult question why in later times, when the rival systems of Common Law and Chancery had become established, when each had

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formed a regular practice, and created by its decisions a body of substantive law, some effort should not have been made to weld them into one. The explanation seems to be simply this, that such an attempt would have been laborious and difficult, and that it was never called for by the people, because they never understood the matter, and did not complain of practical injustice. The existence of two separate jurisdictions involved suitors in much needless delay and expense, but in the main and at last justice was done. If there was no remedy for a wrong at Common Law, there was pretty sure to be one in Equity; and the sort of indefiniteness with which Equity was so long reproached made it more elastic and permitted it to go on developing such new lines of beneficial activity as the changing needs of the time required. And if it be asked why statesmen and lawyers did not endeavour to bring about a reform whose advantages they must have seen, other reasons may be suggested. Most Englishmen are indifferent to what is sometimes called logic, but which it might be better to call philosophical symmetry of arrangement. We take little or no intellectual pleasure in the consistent working out of principles; we are contented if a practical end is somehow gained, and have always been more anxious to gain it in substance than to gain it in the most elegant and rational way. Moreover, the forms of our law, as being associated with our civil liberties, have acquired a sanctity rarely yielded to forms of law in other countries, and with us even bold reformers have often been unwilling to change rules or usages which, though no longer important, were endeared

to the people as having been formerly safeguards against oppression. And a third reason may be found in the fact that we have had no great political convulsions. The continuity of the developement of the English Constitution is unbroken, and the courts are bound up with the Constitution. No revolution has cleared the ground of old forms or shattered the respect for old names and beliefs. No despot has arisen able to carry out comprehensive changes by his solitary fiat. Annihilating the feudal baronage, the dynastic wars of the fifteenth century scarcely altered the legal rights of Crown and subject, or the character of the administrative Government. The Republicans of the Commonwealth did not yield to the Royalist party in their respect for the ancient institutions of the country,—it was indeed in the name of those institutions that they resisted the revolutionary policy of Strafford. And the great Protector, when more absolute master of England than any king had been before him, though he and his advisers planned wide measures of reform, some of which we have not yet been able to carry out, planned them all upon the ancient lines, and proposed to work them in the ancient spirit.

A time however was to come when this respect diminished under the action of new forces. The democratic spirit is a powerful solvent; and England, whether we like it or not, is no doubt becoming more democratic. As a tendency to complexity and technical formalism belongs to the earlier stages of civilisation, so the desire for simplicity and directness is one of the most characteristic marks of this modern spirit, almost

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as much so as that disposition to question ancient beliefs and to treat with scant reverence ancient institutions, of which we discover so many signs around us. In a democratic age men are apt to have an extreme, perhaps an exaggerated, belief in the wisdom of public opinion, and, by consequence, in the wisdom of their own age. They desire to understand the system they live under; they are impatient of restrictions and technicalities; they often fail to appreciate the value of forms, and cannot see the reason, which may sometimes be the absolute need, for subtleties and circuities. They are jealous of a privileged profession with its mysteries, and are ready to suspect an abuse and a selfish motive for maintaining it, wherever they see an anomaly and do not at the same moment see a defence for it which can be made intelligible to the untrained mind. And it must be admitted that there was a good deal in English law, or rather in its working, some sixty years ago, to justify the worst suspicions.

The influence of other nations, though less powerful upon us islanders than it is on the rest of Europe, has still had a great effect in sapping our veneration for the old customs of the country; for that influence has been, since the American and French Revolutions (except during the reaction of the Great War), of a strongly destructive character. And both the poetical and historical revival, whose beginnings we may place some eighty years ago (at least under some of its aspects) and the influence of the methods of physical science, have had a similar effect in familiarising people with the idea of change, leading them to expect a happier age from social reforms, encouraging them to

criticise all things, even producing a certain desire for rationality and symmetry in the provisions of the law and in its administration. Curiously enough, the movement towards legal reform began just about the time when the last stage in the separation of law and equity was reached by the growth of a distinct body of equity practitioners. Its first triumphs were won in the removal of the grosser harshnesses and injustices of our criminal law and law of evidence, due to the writings of Bentham and the parliamentary exertions of Romilly and Brougham. The stimulus of the Reform Bill of 1832 produced, besides such administrative measures as the New Poor-law and the Municipal Corporations Act, the long series of amendments in the law of real property during the last and the present reign, which have so completely changed its aspect, and a great many less conspicuous yet valuable changes in the management of the courts, especially of the Court of Chancery. Then, when the graver evils and injustices in the substance of the law had been removed, attention came to be given to a more difficult matter, its defects in point of form. Its prodigious bulk, its hopeless confusion, its want of leading principles, were pointed out, and people began to be shocked by what their grandfathers had admired, the spectacle of rival courts exercising independent and conflicting jurisdictions, sending the unhappy victim through one chamber of justice after another, and perhaps turning him out at last without redress, because his money or his patience was at an end. Partial and tentative remedies were first applied. By the Common Law Procedure Acts, passed twenty

years ago, Common Law courts were empowered to receive Equitable pleas; that is to say, to give effect by way of defence to rights which had previously been cognizable in Chancery only; and by several other Acts, passed at intervals, Equity courts received and were enabled to deal with matters, such as the determination of issues of fact and the awarding of damages, which it would previously have been necessary for them to hand over to courts of Common Law. These remedies, however, proved to be inadequate, and as the public opinion of the profession ripened, it was seen that nothing less than a complete union of all the discordant jurisdictions would meet the evils complained of. To effect this, however, there were not only so many difficulties of detail to be grappled with, but so strong a sentiment or prejudice in favour of the old system to overcome, that it may be doubted whether it would have been effected in our days, but for the impetus given, or rather the indirect influence exerted, by the Parliamentary Reform Act of 1867. Not that the remodelling of the judicature was a measure for which there was any popular clamour; unfortunately, there is far too little popular interest in reforms of the law which have no connexion with a party platform. But both the Act of 1867 and the sudden and unexpected manner in which it was carried through, appear to have given a sort of shock to men's minds, loosening their faith in the stability of existing political arrangements and disposing them to entertain projects of change which not long before would have been thought, if not revolutionary, at least distant or impracticable. Hence, when the Bill of last session was introduced by

the Lord Chancellor, there was far less opposition made either by the legal profession, always conservative in its own affairs, or by his political opponents, than might have been expected. The scheme proposed had been approved by a Commission, in which the highest judicial and forensic ability of the country was represented; and when it came on for discussion the great Conservative lawyer of the House of Lords was magnanimous enough to abstain from any factious criticism, and controversy turned chiefly on one or two political rather than legal questions and on some administrative points of no great interest. Nevertheless, so great were the technical difficulties that might have been raised, that probably nothing less than the extraordinary professional reputation of the Lord Chancellor, and the respect which his brilliant talents and the singular elevation and disinterestedness of his character had won for him from all parties, would have made it possible to carry in one session a scheme which changes the whole face of our judicial administration, sweeps away all the courts which the labours of seven centuries had built up, and proposes to found a new system of pleading and process.

Laymen may be glad to be told in a summary and untechnical way, and omitting matters of detail, what precisely it is that this great measure effects.

It unites all the pre-existing Superior Courts, whose growth out of the Lesser Council or Curia Regis we have traced,—viz., firstly, the Court of Chancery, in its six, or more properly five, courts, the Lord Chancellor's and the Lords Justices', the Master of the

Rolls', and the three Vice-Chancellors'; secondly, the three great courts of Common Law,—Queen's Bench, Common Pleas, and Exchequer, together with their complex appellate Court, the Exchequer Chamber; thirdly, the Court of Admiralty; fourthly, the Court of Probate, and the Court for Divorce and Matrimonial Causes; fifthly, the London Court of Bankruptcy; sixthly, the Court of Common Pleas at Lancaster; seventhly, the Court of Pleas at Durham, as well as the Courts of Assize, Oyer and Terminer, and Gaol Delivery over the country—into one new Supreme Court of Judicature, to which are given all the powers and duties of all these several courts.

It divides this new court into two branches, one to be called Her Majesty's High Court of Justice, exercising original jurisdiction; the other called Her Majesty's Court of Appeal, having an exclusive appellate jurisdiction from the High Court.

It abolishes the jurisdiction of the House of Lords in all English appeals,* and transfers to the new Court of Appeal the appellate jurisdiction of the Judicial Committee of the Privy Council in all Admiralty causes, while also empowering Her Majesty to transfer to it the jurisdiction of the Privy Council in ecclesiastical and other appeals. The jurisdiction of the House of Lords in Scotch and Irish appeals is, for the moment, left subsisting.

* As the House of Lords in its judicial capacity, although practically a law Court in which only professional lawyers sit, is still in theory a part of the Great Council of the nation, the abolition of its appellate jurisdiction is the removal of a feature which carries us back to the most remote antiquity of our race,—the union in one assembly of administrative, legislative, and judicial functions.

It makes all rights previously recognised in any one of the abolished courts available in and enforceable by the new Supreme Court, and empowers it to award all the remedies which any of such abolished courts could have given to a suitor; or, in other words, it extinguishes all distinction between Law and Equity, directing that wherever there was previously a conflict between them, the rules of Equity shall now prevail.

It makes several changes in the substance of the law intended to facilitate this fusion.

It introduces a new and uniform system of procedure to be followed in the Supreme Court, combining, as it is hoped, the respective merits of the ancient rival systems of the Common Law courts, the Equity courts, and the Court of Admiralty.

It splits up the new High Court of Justice into five divisions, for the better despatch of business, and directs what sorts of causes shall be heard by each, providing for the easy transference of business from one division to another.

These five divisions are to be respectively called the Chancery Division, the Queen's Bench Division, the Common Pleas Division, the Exchequer Division, and the Probate, Divorce, and Admiralty Division, and are each to receive (speaking generally), in the first instance, the same sort of business which the existing court of the corresponding name has been accustomed to deal with. This is partly a concession to historical or conservative sentiment, partly an expedient for breaking the shock of change, and facilitating the passage from the old procedure to the new; a difficulty which is further met by the provision that the former

rules of practice, so far as not expressly changed by the Act, shall remain in force. In so far the old arrangements are perpetuated. But in other respects the revolution is complete. All the ancient things, all that luxuriant and tangled jungle of jurisdictions, rules, forms, conflicts of right, varieties of remedy, which had sprung up and flourished since the days of Henry II., are swept away, as if by a sudden conflagration. We are, in fact, brought back to the condition in which we were in the middle of the twelfth century, when there was one King's Court, with its lower division or committee entertaining ordinary suits, and its higher one receiving those graver causes which were proper to be reserved for the consideration of the Sovereign himself in his ordinary Council. Out of that committee grew the three great Courts of Common Law—out of that ordinary higher Council grew the Courts of Chancery and the Privy Council, now all welded again into one; while we are in so far more fortunate than our ancestors that those Ecclesiastical Courts against which King Henry strove so fiercely are now also united into the Supreme Court of the Sovereign, and one uniform system of pleading and process is established for all. The long course of evolution is complete, and England starts afresh upon new lines.

Yet she has not broken with the past. In abolishing old forms, the substantial treasures they enshrined and sometimes concealed have not been lost. It has been an incalculable advantage of the divided systems of judicature that they have allowed different modes of procedure to be worked freely out and their respective merits to be tested; the Common Law

courts, for instance, taking evidence orally, the Chancery courts in writing, the Common Law courts requiring pleadings to be comparatively brief, strict, and technical in form, the Chancery courts permitting them to be copious and easy. So, too, the later growth of the Court of Chancery and its undefined position, representing the Sovereign's administrative discretion as the source of justice to his subjects, enabled it to give effect to many rights and apply many remedies which a regularly-organised court would have found it hard to deal with; while the maintenance and developement by the Common Law courts of the ancient jury system, which might have perished (at least in civil causes) had the Chancery earlier absorbed those courts, has been made the means of building up, by the aid of the commercial community itself, a body of mercantile law, which for fulness, exactness, substantial justice, and adaptation to the needs of modern society, may fairly claim to be without a rival. Without, therefore, considering ourselves the peculiar favourites of Providence, or in any special sense the heirs of all the ages, we need not regret that this great reform did not come sooner. It was well that the diverse systems should expand themselves independently and bear their several fruits after their kind; but now, when the era of developement had apparently closed, it is also well that their separate life should cease, and something be planted in their place which may, as far as possible, combine their merits and avoid their faults.

How far the new court and the new system of procedure (of which the schedule to the Act gives an outline to be filled up by rules now in process of con-

struction) will succeed in doing this, experience only can show. There was little difference of opinion in the profession as to the need for some change, and there has not been very much even as to the propriety of the way in which it has been effected. Some critics, to be sure, think that the appellate jurisdiction of the House of Lords ought to have been spared, and others that the special powers and modes of procedure of Equity courts ought to have been more fully preserved; while others again, who are perhaps nearer the mark, hold that if there has been an error, it is in conceding so much to sentiment or custom, in suffering the divisions of the High Court to retain so much of an independent existence, and thus leaving a door open by which some of the former diversities of usage and process may possibly creep back to their old haunts. It cannot be denied, that there is some risk of this, and that the ultimate success of the intended fusion will greatly depend on the rules of procedure now to be framed, and on the way in which the Act is worked by the Judges during the next few years. But everyone admits the great promise of good which the change holds out, and the honour which its author has won for himself by the comprehensive boldness of his scheme, by the ingenuity with which its details have been worked out, and by the tact and skill with which it has been piloted into harbour through so many rocks and shoals. The Judicature Act, and the minister who framed and passed it, will have a place in the history of England when nine-tenths of the contests of our day have passed into oblivion.

The benefits which may be expected from it are

of two kinds. Justice, we hope, will be better administered under it, and it will pave the way for other great and necessary reforms in the law.

The advantage of having all rights recognised in every court, and made capable of being adjudicated on thereby, is too obvious to need explanation. No man, as somebody has neatly put it, will henceforth be turned out of the temple of justice because he has come in by the wrong door. Hitherto it has constantly happened that a suitor in Equity has been told that his remedy was at Common Law, and a suitor at Common Law has been sent across to Equity. A defendant at Common Law has not been able properly to state or use there his grounds of defence or his counter-claims, but has been obliged to institute a suit in Equity to make them available. Or he has found it necessary to discover facts within his adversary's knowledge, and has had to file a separate bill in Equity to compel their disclosure. Besides the delay and expense to which individuals have thus been put, the country at large has incurred needless cost in maintaining separate judicial establishments; and the substance of the law has suffered by the uncertainty and confusion caused by the different views which different courts took of the same legal relation. All these and many minor inconveniences ought now to disappear; justice ought to become easier, speedier, more certain, more complete; and (which is a consideration of some moment) the principles on which it is administered ought to become much plainer to the ordinary citizen.

To these palpable advantages of the fusion of Law and Equity there are to be added those which

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may be expected from the establishment of one new supreme Court of Appeal in place of the various present ones. Hitherto Common Law appeals have gone in the first instance to the Court of Exchequer Chamber, and thence to the House of Lords; Chancery appeals first to the Lord Chancellor and the Lords Justices, then to the House of Lords; appeals from the Probate Court and Divorce Court to the House of Lords; while the Judicial Committee of the Privy Council has received appeals from the Court of Admiralty, from the Courts of India, from the Colonies, as well as Ecclesiastical appeals from the Courts of the Archbishops. The inconvenience of this system was, that if the Privy Council and the House of Lords took different views of the law upon the same point, there was no means of reconciling their divergence; and if the Exchequer Chamber and the Chancery Appeal Court took different views, the only means of determining which was right, viz., an appeal to the House of Lords, might not be put in force, because neither party might care to appeal. Hence in this conflict of authorities the law might remain unsettled, an evil greater, in a lawyer's eyes, than a decision the wrong way. As there is now but one supreme Court of Appeal, this difficulty can no longer arise, for although it will apparently sit in divisions, each of such divisions will be disposed to follow the decisions of every or any other division, or else to bring the point on which they may doubt the correctness of a former decision before the full court, to be finally set at rest by its opinion.

The Judicature Act has, however, a further and

perhaps even higher importance as a first step, a necessary preliminary, to other great amendments in the law of these kingdoms. There are, over and above the simplification of the law of real property, which is too technical a matter to be discussed here, and is moreover to be dealt with in the coming session, three such that seem now specially called for. Firstly, the reduction of the whole body of the law to the shape of a code or digest; secondly, the creation of a permanent legal office or legal department of Government, by which the miscellaneous business now thrown upon a variety of officials, and neglected or imperfectly discharged by many of them, may be systematically and promptly despatched, and by which, in particular, Acts of Parliament may be drawn and revised with some regard to symmetry and clearness; and, thirdly, the assimilation of the laws of England and Scotland.

Now the first of these, Codification, if more important than almost any reform in the positive provisions of the law, is also a matter of infinitely more time and labour. As respects its intrinsic merits, or what may be called its contents or substance,—its copiousness, its precision, its flexibility, its practical fairness, the spirit of freedom which breathes throughout it,—the law of England may be pronounced one of the most, perhaps the most, satisfactory system that the world has ever seen. As respects its form, it is probably the worst. The statute law contained in Acts of Parliament is huge in bulk, endlessly prolix and often hopelessly obscure in expression. The customary or case law is scattered up and down through hundreds of volumes of reports, and is there stated, not in general rules, but in the form of

decisions on particular conditions of fact. Many of these reported cases are obsolete, many are of doubtful authority, many conflict with one another. There is a pleasing fiction that all the Queen's subjects know the law, and at Westminster as at Rome the maxim holds, *ignorantia iuris nocet.* But the truth is that in our days the maturest sages of the law do not hope to achieve more than to know where to find it; and to accomplish this, even with the aid of our vast library of text-books, demands the labour of many years. As the need of a codification of this mass of statutes and cases grows more pressing every year with the increase of legislation and of reported decisions, so does the difficulty increase in like proportion. An attempt was made several years ago, when the Digest Commission, composed of nearly all the most eminent judges and practitioners, was appointed to produce a scheme; but after issuing a report, strongly in favour of beginning at once, it ended by abdicating its functions and throwing the undertaking back into the hands of the Executive Government. Now, however, the enterprise may be resumed with a better prospect of success, for the fusion of jurisdictions effected last session has removed a great preliminary difficulty. Equity has swallowed up Law, or, to put the same thing differently, Common Law courts have adopted Equity. We shall no longer have independent tribunals creating different law from opposite points of view: repugnancies will disappear: common underlying principles will come out in their real prominence. Some of those statutes and many of those numerous cases which prescribed or governed the practice of the old courts will have become useless, and may be omitted

in any future redaction; so have all those cases, often very perplexing, which showed when recourse should be had to Chancery and when to Common Law, or how far the former would interfere with the latter.

There is reason to believe that the true way of digesting English law is not to grapple with so vast an enterprise all at once, or try, as most people have hitherto talked of trying, to carry a code *uno ictu*, so to speak, but to break up the work and deal with it piecemeal and by degrees, beginning with what is easiest, the consolidation of the Statute Law, and then, having framed a comprehensive scheme for the arrangement of the whole body of the law under appropriate heads, to proceed to codify separately each head, bringing together in a more concise form the substance of the existing statutes and cases, together with such amendments as may be needed to make the main principles running through them more distinct. The leading merits of such a redaction (which in some instances would imply very little material change) would be its symmetrical arrangement and the exactness of its expression: it might be drawn in the form of an Act, and such Act could then be submitted to Parliament and passed into law. The law of evidence, for example, might thus be dealt with in England, as it has been in India; so might the law relating to bills of exchange, to insurance, to carriers, and so forth. In this way the present chaos of rules would in process of time be reduced into a harmonious and self-consistent whole, the experience acquired in the progress of the work making its later parts better than we could expect any of it to be if it

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were done, as Justinian created his Corpus Juris, by a single effort. And the first step towards this scheme, which law reformers in England are beginning to think the most feasible, is, I venture to believe, the creation of a permanent legal department of Government, which would carry on the work of digesting old law as well as that of framing new law in a steady way and upon fixed and rational principles, while at the same time advising the Executive upon legal questions, undertaking the duty of public prosecution, and in various other ways providing for the despatch of a quantity of miscellaneous legal business, which is now neglected, because the responsibility for it is divided among different offices.

There remains a third great reform, on which, remote as it is, a word or two may be said, and to which the Judicature Act has certainly brought us nearer—the assimilation of the laws of England and Scotland. As to its practicability, at least during this or the next generation, there may be much difference of opinion; as to its desirability there can be very little. Neither law can absorb or replace the other, for each has its characteristic merits; the law of Scotland excelling in system and brevity, that of England in fulness and subtlety of distinction,—the greater population of this country having given rise to a much greater number of cases for judicial solution. Now, with the passing of the Judicature Act, the fusion of the two laws may be thought to have come within the sphere of practical questions. While England had several independent sets of judicatures, administering different sets of rules, Scotland could

not have been asked to link herself to such anomalies; but now a change has been made from the old procedure to that which will be developed under the new Supreme Court quite as considerable as would be the adoption by the Court of Session of this same new English practice. In fact, as has been remarked already, this new practice resembles in many points that of the Scottish courts, and this not unintentionally, for the neatness and conciseness of the Court of Session pleadings which our English leaders have had to deal with as counsel in appeal cases appear to have made a favourable impression on them, and to have suggested that English pleadings might to some extent be modelled thereon. And, further, while the law of England remains the shapeless congeries of statutes and cases that it is now, the adoption even of parts of it by Scotland would be almost impossible, as indeed it is no easy matter to ascertain how far it differs from Scots law at present. But now, when the prospect of codifying the English law begins to dawn upon us, this difficulty appears far less serious. And the most hopeful mode of assimilating the two laws will be that which has already been suggested as the right mode of codification, viz., to take up various departments of the law in succession, beginning with those where the need is greatest and the divergences caused by the different economical and social conditions and associations of the two countries are least marked, and in these departments to gather the law into a codifying Act, enacting it for England and Scotland both. Such a scheme was shadowed forth long ago by Lord Hardwicke in an interesting letter

to Lord Kaimes (printed in the *Life* of the latter), and he suggested the criminal law as a proper department to begin with. Many heads of mercantile law might be similarly dealt with, as well as the law of persons, where, though the obstacles to be overcome—especially as regards marriage—are considerable, the necessity for a uniform law is very pressing. When, therefore, the work of codification begins to be seriously undertaken among us, it seems important that an effort should be made to enable the law of England, in borrowing some of the merits of the Scottish, to assume a shape in which it may eventually serve both countries, and put the finishing touch to that growing harmony of national feeling, character, and institutions from which both countries have gained so much.

Over and above the direct improvements to be expected in the administration and amendment of the law, one may venture to believe that this Act, and the further reforms it leads up to, will exercise an influence greater than may at first sight appear on the well-being of the legal profession, and, through it, of the whole country. The social status of the English Bench and Bar seems threatened with a decline, through the growth of the power of wealth generally, and particularly of the number of great commercial fortunes. This is certainly one of the chief causes which have lowered it in America. Nothing will better contribute to sustain it than the introduction of more harmony and symmetry, of more of what may be called a scientific character, into the law itself and its organs, the courts. For not only will a regular legal education

become more frequent and more valued, maintaining the level of mental culture throughout the profession, but the mere habit of working an elegant, harmonious, and rational system of law by the simple yet skilfully-constructed mechanism of our new courts, ought of itself to tend to inspirit and discipline the lawyer's mind, to give him a livelier sense of the dignity and intellectual worth of his profession, and to keep him, under the new temptations which may probably thicken round him here as they have on the other side of the Atlantic, sensitive to its honour, and eager to see the abstract propriety and consistency of the law seconded and sustained by a pure administration of justice. And how important the integrity and public spirit of this profession are to the whole nation, not only because they are the depositaries of private confidence and the guardians of legal administration, but on account of the great part which they must always have to play in local and imperial politics, is too obvious, and too amply illustrated by the history of France and America, as well as of England, to need further illustration here.

An address on an Act of Parliament, if it is to be intelligible to a layman, must be comparatively trite to a lawyer; and perhaps laymen as well as lawyers may think that after undertaking to give an account of this Act, I have strayed too far from it into both the past and the future. But does not the special interest which attaches to this measure consist greatly herein that it carries us back to the foundation of our judicial system? and is it not our duty, in an institution like Owens College, to endeavour to apply to the

most familiar social and political and legal questions the methods of historical and philosophical enquiry, just as the masters of physical science illustrate the highest laws of force and combination from the commonest phenomena of external nature? If this be properly done, something, one cannot but think, is gained for the pleasure and profit of the life of each of us, as well as for our comprehension of the subject. A profession in the ordinary practice of which there is much that is tedious and even narrowing, needs to be, and may be, elevated by the reflection that as the rules we apply in an ordinary case are deduced from and illustrate wide scientific principles, so the actual arrangements among which we work, the courts we enter as attorneys or counsel, the forms of procedure we employ, the very legal language we speak, have all their inner meaning and their history, and come down to us, like the inscribed bricks of the ruined cities of Assyria, covered with records of the past, which are full of instruction for us if we will but decipher them. And, similarly, the ordinary citizen acquires a higher conception of the national life he is called to bear a part in, when he recognises the relation of modern institutions to those of primitive and mediæval times, when he knows and understands who were the men who created them, what were the purposes they have served, what the contributions they have made to the happiness and greatness of England. In this way scientific enquiry helps to educate the individual, while it may also render material services to practical politics, services far greater than so-called practical politicians are generally

willing to admit. It is surely the special function of universities—and Owens College may already claim to be a university in spirit—so to train its students that they may endeavour thus to seize upon passing events and actual problems, apply to them an impartial analysis, and pour round them the mellowing light of history, raising them out of the dust and din of controversy, and disclosing the principles by which they must be judged, or on which their solution depends.

Such a topic, I venture to think, is the reform of our judicial system which was effected last session. For it is the mature and definite reorganisation of that machinery which is, after all, the great end for which government and political society exist—the doing of justice between man and man; a machinery whose intricacy and whose inestimable value we are sometimes apt to forget, just because it is so familiar and works so smoothly, even as the ancients said of the fancied music of the spheres, that it is never heard because it is never silent. It is the renewal and purification of the elaborate product of a long and glorious past, intimately associated with the English liberties which our ancestors won in the sacred name of the Law. It is the gateway through which we must pass to other reforms of not less ultimate value. And, however little notice it may have received among the political contests and intrigues of the moment, future students of English institutions will be disposed to regard it as one of the greatest landmarks in their developement. With the passing of the Judicature Act we have closed one great historical

:le, rich with the labour and thoughts of many ierations; and we stand now on the threshold of other, destined, we may hope and we may fairly st, to be not less fertile, not less worthy of the :e which has given its laws, as well as its language, so large a portion of the civilised world.

JAMES BRYCE.

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XIII.

THE RAILWAYS AND THE STATE.

A LITTLE experience is worth much argument; a few facts are better than any theory; the Government manages the Post Office with success; by a great reduction of charges it has created a vast business, and earns a satisfactory revenue; the Government has purchased and successfully re-organised the telegraphs, and is making them pay; *therefore* the Government ought to buy the railways, and we should then have railway fares reduced to a third of their present amounts, trains very regular, and accidents few or none. Such are, briefly stated, the reflexions which have led many persons to join in an agitation, lately increasing, to induce the Government to undertake the gigantic task of acquiring, re-organising, and even working the whole system of railway conveyance in this kingdom. Although many other reasons, of more or less weight, are given for the change advocated, I believe that the main argument, consciously or unconsciously relied upon, is, that *because* the State Post Office and State Telegraphs succeed, *therefore* State Railways would succeed.

The argument from the Post Office is, in fact, continually appealed to. In his article upon the subject in the *Contemporary Review* of July last, Mr. Arthur

Arnold says: "I regard the work of the railways as only a magnified postal system; the carriage of men and women, of boxes and bales, differs only in degree from that of letters and packets: as to the business of the State, it is evidently as lawful to do one as to do the other" (p. 248). He says again: "I conceive it possible that some day passengers and goods may travel by railway, as letters and parcels do by post, at one uniform rate—the same whether they be going thirty miles or three hundred" (p. 254). Mr. Galt, in the preface to his prolix work upon *Railway Reform*, published in 1865, describes the results of Sir Rowland Hill's postal scheme, and then asserts distinctly: "The same principles applied with equal force to the conveyance of passengers and goods by railway, as to the conveyance of letters by mail-coach" (p. xviii.). In his recent paper, printed in the *Fortnightly Review* for November, he repeats the same notions: "No better illustration could be given of the result that might be anticipated from a reduction in passenger-fares than what our experience affords us during the last thirty years by the reform of our Post Office, and the reductions effected in Custom and Excise duties. The cases are in every respect analogous" (p. 576).

Exactly similar ideas pervade the paper of Mr. Biddulph Martin, read before the Statistical Society in June last, as well as the speeches of his supporters in the important discussion which followed. Even so profound and experienced a statistician as the President, Dr. Farr, was misled, as I think, into asserting that "the railway system may, like the Post Office, put every station in easy communication with every other

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station; and some future Rowland Hill may persuade Parliament to do for fares on the State railways what it has done for the postage of letters."

I need hardly stay to demonstrate that facts are valueless unless connected and explained by a correct theory; that analogies are very dangerous grounds of inference, unless carefully founded on similar conditions; and that experience misleads if it be misinterpreted. It is the party advocating State management who indulge in argument, theory, and speculation; and it is my purpose in this Essay to show that their arguments are unsound, their theories false, and their speculations chimerical. They misinterpret experience, they assume some doubtful facts, and they overlook other unquestionable ones; they advocate a measure which is fortunately so nearly impracticable, that there is no appreciable chance of its being carried out, but which, if it really were undertaken, would probably land us in great financial loss and much embarrassment.

All reasoning, no doubt, consists in arguing from case to case: we have experience of one trial, and we infer that what happens in this case will happen in similar cases. But, before drawing any such inference, we must carefully assure ourselves that the cases really are similar. If in regard to State control the railways are similar in economic and mechanical conditions to the Post Office, we may expect them to be successfully managed by a Government department; but if, as I believe, they lie under totally different conditions, the inference would be false, and we must look to quite different experience to teach us the probable result.

In a paper read before the Manchester Statistical

Society, in April 1867, as also in evidence given before the Select Committee of the House of Commons on the Electric Telegraphs Bill, in 1868, I advocated the purchase of the Telegraphs, on the ground that there was substantial similarity of conditions between the Telegraphs and the Post Office. There appear to be four principal conditions under which State management of any branch of industry is successful:

(1.) The work must be of an invariable and routine-like nature, so as to be performed according to fixed rules.

(2.) It must be performed under the public eye, or for the service of individuals, who will immediately detect and expose any failure or laxity.

(3.) There must be very little capital expenditure, so that each year's revenue and expense account shall represent, with approximate accuracy, the real commercial success of the undertaking.

(4.) The operations must be of such a kind, that their union under one all extensive Government monopoly will lead to great advantage and economy.

I need hardly point out in detail that these conditions are almost perfectly fulfilled in the postal system. The public often seem to look upon the Post Office as a prodigy of administrative skill; they imagine that the officers conducting such a department must be endowed with almost superhuman powers to produce such wonderful results. Many of those officials are doubtless men of great ability and energy; nevertheless, it would be more correct to say that the great public services and the satisfactory net revenue of the Post Office, are due, not to them, but to the nature of postal communi-

cation. As Adam Smith said, "the Post Office is perhaps the only mercantile project which has been successfully managed by every sort of Government." In spite of the defects inherent in all Government management, the Post Office yields a revenue, because the economy arising from a single systematic monopoly is enormously great in this special case.

I must draw attention to one point of postal administration which is entirely overlooked by the advocates of State Railways, namely, that the Post Office department has always avoided owning any extensive property. They own the buildings at St. Martin's-le-Grand and the principal offices in some other large towns; but in all the smaller towns and villages they hire accommodation, or merely pay for it in the general remuneration given to the postmasters. For the rapid and regular conveyance of the mails the Post Office is entirely dependent upon the much-abused railway system, without which, indeed, the post, as we now have it, would be impossible. Not even the horses and vehicles employed in the local collection and distribution of bags are the property of Government, being furnished, I believe, entirely by contract. From the latest Report of the Postmaster-General, we learn that the total expenditure of the Postal and Money-order Department in 1872 was 3,685,000*l.*, of which 1,682,000*l.* was paid in salaries, wages, and pensions; 928,000*l.* for conveyance by mail-packets and private vessels; 619,000*l.* for conveyance by railways; 145,000*l.* for conveyance by hired coaches, carts, and omnibuses; while only 164,000*l.* was expended upon buildings in the possession of the Post Office, and upon the taxes, fuel,

lights, &c., required in those buildings. The last item, too, was unusually large during the year 1872, owing to an exceptional expenditure of 48,000*l.* on new buildings. On the average of the fifteen years, 1858–1872, the whole expenditure on buildings, repairs, and other requisites, has not exceeded 120,000*l.* per annum, in addition to 22,000*l.* or 23,000*l.* a-year for mail-bags. Much of the recent expenditure on buildings must be charged, too, on the money-order and savings'-bank business of the department.

The state of things is somewhat different in the Telegraph Department; for though telegraphic work is favourably situated as regards the first, second, and fourth conditions, it involves a considerable amount of capital expenditure. The cost of the Telegraphs in the possession of the Postmaster-General already amounts to nine or ten millions, and it will probably have to be increased from time to time. The working of this Department will, no doubt, afford us valuable experience in the course of ten years for judging as to the practicability of State interference in other branches of communication; but I hold that the few years yet elapsed since the purchase are insufficient to enable us to estimate the real results. A profuse expenditure of capital is still going on, and large claims against the Department are still outstanding. If we must draw inferences, they will, in my opinion, be of an unfavourable character. We learn that in effecting a compulsory purchase even from four or five comparatively weak companies, a premium of about 100 per cent. must be paid by the public. Great indignation has been expressed at the prices which railway companies have to pay in the pur-

chase of land; but equally bad cases might be found in the Telegraph bargains. If the reports in the newspapers are to be trusted, the Isle of Man Telegraph Company received 16,106*l.* for their business and property, which allowed a distribution of 11,774*l.* to shareholders, who had paid up 5,000*l.*: so poor, however, had been the previous prospects of the company, that the shares might have been bought some years before at 5*s.* per 20*l.* share, or less than the one-hundred-and-sixtieth part of what was obtained from Government. Generally speaking, the holders of Telegraph-shares received twice as much as the commercial value at which their shares had been previously rated.

In February 1868, after the Telegraph-shares had somewhat risen, Mr. Scudamore estimated, in his official report upon the projected purchase, that the property and business of the Telegraph Companies would cost, at the most, three millions, and, adding 100,000*l.* for the intended extensions, he named 3,100,000*l.* as the required capital of the Department at the outset. In April 1867, before the shares had risen, I had estimated the purchase-money as not likely much to exceed two-and-a-half millions, to which I added an equal sum for the extension of the property. The actual cost of the scheme as yet cannot be stated at less than three times Mr. Scudamore's estimate, or nearly twice my own.

If we overlook the gigantic blunders made by the Department in conducting the purchase, and pay regard merely to the subsequent financial management of the Telegraphs, we find little to give us confidence. Twice

has the Department defied the Treasury and the House of Commons by spending money without authority—the first time to the extent of 610,000*l.*, the second time to that of 893,000*l.*; these great sums being drawn from the general balances in the hands of the Department, involving a distinct breach of trust as regards the Savings' Banks balance. I need hardly mention the details of these extraordinary transactions, which will be familiar to many of my readers. The public seem to have condoned these irregularities with a facility which it is difficult to account for or to acquiesce in. The newspapers said that, if we are to have State Telegraphs, we must find bold energetic officers, who will manage them with independence for the good of the public, and will not allow slight difficulties to hamper them. To put forward such a plea is to condemn State Control altogether. If the circumlocution inherent in the relations of the Government offices, and the slowness of action of Parliamentary government be such, that the officers of an industrial department cannot successfully carry it on without defying all superior authorities and breaking the laws under which they hold funds, this is the strongest possible objection to State industry. Such difficulties never arose in the postal work, because, as I have said, the capital expenditure is there quite inconsiderable, and the current expenditure very regular in amount, so as to be easily estimated and controlled. Now, if out of a total not yet amounting to ten millions, a Government Department has managed to spend a million-and-a-half without authority, what may we expect if a few energetic officials hold in their hands a property, of which

the very lowest valuation is six hundred millions sterling, and a far more probable valuation a thousand millions? The Treasury does not even undertake to manage its own National Debt, the work of which is placed in the hands of the Bank of England. I tremble to think what might be the financial results if a property exceeding the National Debt in nominal value, and requiring in every part of it constant repairs, renewals, and extensions, were in the hands of a Parliamentary Minister, who might find some day that he had been illegally and ignorantly signing away great sums of money at the bidding of his subordinates.

Coming now to the subject of railways, it must be allowed that railway communication presents some conditions favourable to State Control. The larger part of the traffic can be carried on according to a pre-arranged and published time-table, so that the public, whether in travelling or transmitting goods, will have apparently as good means as in the Post Office of scrutinising the efficiency of the department and exposing any laxity. The union of all railways in one complete system would allow of much economy in superintendence, in the use of the rolling-stock, the avoidance of competing trains, and so forth. The public would be saved from that most annoying circumstance, the missing of a train when passing from the lines of one company to those of another. It is commonly said, too, that enormous advantages will arise to the country when the rates of passenger and goods traffic are arranged with regard to the interests of the people rather than the interests of the shareholders. The elaborate system of classified rates for goods might be done away with, and all goods

carried at two or three simple rates, little above the cost of carriage. I shall have to discuss various proposals which have been made, and will now only remark that the success of the Post Office is due to principles of management often exactly the reverse of those which it is supposed that the Government would apply to the railways. Mr. Galt and others strongly object to one kind of goods being charged differently to other kinds, when the cost of conveyance cannot be very different; but the Post Office charges a penny for the lightest letter, while it conveys two ounces of printed matter for a halfpenny. The very different postal rates for books, newspapers, letters, and cards, form, in fact, a tariff carefully classified so as to produce a net revenue, and unless the somewhat high rates on sealed letters were maintained, this revenue would soon melt away. The Post Office does not pretend to frame its tariff from regard to the cost of the services performed.

When we look more closely into the question of railway management, we find all analogy to the Post Office vanishing. Not only is the capital of vast amount, being in 1871 of a total value of 552,682,000*l.*, but this capital is represented by property of the most various and complicated nature. There is not only the permanent way, with all its bridges, viaducts, tunnels, embankments, and other works, but thousands of station-buildings of all sizes, warehouses, sheds, repairing-shops, factories, offices, wharves, docks, &c., &c. The locomotive department has the charge of about 10,500 engines, needing constant care and repairs; the rolling-stock department owns about 23,000 passenger-carriages, at least 276,000 waggons of various kinds, and

other vehicles, making a grand total of more than 312,000, exclusive of locomotives. The railways of the United Kingdom undoubtedly form the most elaborate and extensive system of industrial property existing, and it is strange to reflect that the whole of this vast system has been produced in the last forty years by the genius of British engineers and the enterprise of British men of business. It is especially to be remarked that the property of a railway company forms a connected whole, and in order to secure safety and efficiency every department and every man must work harmoniously with every other.

Now, if we want to know how Government officers would manage such a property, we should look, not to the Post Office, which owns no property of any consequence, but to the Admiralty, which holds the dockyards and maintains a large fleet, or to the Department of Public Works. Unless these Departments are foully slandered, they are not remarkable for economical management. The waste and jobbery which goes on in them is one of the stock subjects of indignant oratory when members of Parliament meet their constituents. Mr. Mellor, M.P., a member of the Committee which was lately enquiring into the mode in which Government stores were purchased and sold, declined to disclose any facts known to him in that capacity, but cited some cases previously made public. Not long ago, for instance, ten or twelve tons of soldiers' buttons, which had never been taken from their wrappers, were sold as old metal. In the sale of old ships the purchaser has in numerous cases received considerably more for stores on board of the vessel returned than the amount

of his purchase-money. Thus the *Medway* of 1768 tons was sold at Bermuda for 2180*l.*, but the Government repaid the lucky purchaser 4211*l.* for spare stores; in short, they gave away the remainder of the ship, with 2041*l.* in addition. Many similar stories, showing the utter want of economy in some Government departments, have, from time to time, been current, and they probably represent a very small fraction of what there might be to tell.

Let us now turn to consider the actual proposals made concerning a reorganisation of the railway system. There are two principal schemes put forward, as follows :—

(1.) The State shall purchase the whole of the railways, and shall undertake all new works and extensions, but shall commit the working of the traffic to contracting companies, who shall lease the lines in large blocks and manage the traffic under the superintendence of the Railway Minister.

(2.) The State shall not only purchase the entire aggregate of railway property, but shall itself work the traffic, in the same manner as the Telegraphs are now worked under the Postmaster General.

It is remarkable that not one of the witnesses examined before the Railway Commission, intimately acquainted as they most of them were with railway traffic, would undertake to recommend the second scheme, though several of them held that great advantages would arise from the plan of leasing the lines in groups. It is especially worthy of notice that an elaborate scheme of the first kind was put forward by Mr. Frederic Hill, of the Post Office Department, in

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his evidence before the Railway Commission, and it was carefully considered and advocated by his brother Sir Rowland Hill, in his separate Report as a member of that Commission. Mr. Frederic Hill has further stated his views in a paper communicated to the Meeting of the Social Science Association at Newcastle-upon-Tyne, when they were fully discussed. The details of the scheme are too elaborate to be described here, and must be sought in the Reports of the Commission and of the Social Science Association (p. 450). Although there is much that is valuable in the proposals of these gentlemen, few have been found to concur in their principal suggestions, and the other members of the Commission declined to accept them. What chiefly strikes me in their opinions is the very distinct way in which Sir Rowland Hill and his brother, both possessing the most intimate acquaintance with the working of the postal system, decline to recommend that the Government should itself manage the traffic. Sir Rowland says: "I do not mean to recommend that any Government Board should take upon itself, in the gross, the duty now performed by railway directors. For the direct management of the lines I propose to provide by leasing them out, in convenient groups, to companies, partnerships, or individuals, as the case may be." Mr. Frederic Hill unequivocally asserts, "that it is expedient that the State should purchase the railways, but that it is not expedient that it should undertake their management." While entirely accepting their opinion against Government management, I fail to perceive how their own scheme could be carried out. It involves all the difficulties attaching to the acquisition, owner-

ship, and extension of the vast railway property, and would, at the best, only secure a portion of the advantages arising from the more thorough-going schemes. I am, therefore, inclined to acquiesce in the opinion of Mr. Martin, who remarked that the leasing scheme appeared to be "an ingeniously contrived mixture of the disadvantages of both systems, without a single redeeming advantage."

It is difficult to see how these leasing companies would differ from the present great railway companies, except that, having sold their property to the State at a profit, they would continue to work the traffic in comparative freedom from responsibility as regards the safety of travelling, or its financial results. Let it be especially remarked, too, that such a proposal runs directly contrary to all experience derived from the Post Office, which, as already stated, confines itself to the conduct of the traffic, while depending upon contractors, especially upon railway companies and steam-boat owners, for the use of all fixed property. Nevertheless, it is seriously proposed that in the case of the railways the State should purchase, construct, own, and repair the fixed property, but should leave individuals to compete for the conduct of the traffic. Perhaps the best-established empirical generalization in political economy —Mr. Mill's opinions to the contrary notwithstanding — is, that the State is the worst of landlords, and it is now seriously proposed to make it the landlord of the whole railway system. It would surely be a much more sensible suggestion that the Government should be the leaseholder, and while leaving the permanent way and other fixed property in the hands of the present com-

panies, under contracts to maintain and repair them as required, should confine its own work to carrying on the traffic in a manner analogous to the postal system. Even to this arrangement, however, there are insuperable objections, especially the fatal division of authority and responsibility which it would produce. Unity of management is the prime condition of efficiency and safety in so complicated a system as that of railway conveyance.

I proceed to discuss in more detail the objections to the second scheme, that the Government should both purchase and work the railways. I dismiss, as of no account, some of the evils attributed to it, as, for instance, the great patronage and political influence which it would place in the hands of the Cabinet. My objections are, that it would realise very few of the prodigious advantages anticipated from it, and that it would probably be a disastrous financial operation. It is impossible that I should find space in this Essay to explain fully the objections arising against the scheme; I must confine myself chiefly to showing that the great advantages expected to accrue from it are illusory, founded on false analogies, and generally inconsistent *inter se*. Government is to give us low fares, better carriages, punctual trains, universal through booking; it is to carry workmen daily to and from their work at nominal charges, to convey goods at cost price, to distribute the mails free of cost, to do away with all the differential charges which enable some companies to earn a fair dividend, while it is at the same time to reap a net revenue from railway traffic, over and above the present average dividends and interest

on loans, and in due time to pay off the National Debt.

Assuming for the moment that the notion of the English Government purchasing and working the whole of the railways is conceivable, my picture of the results would be very different. In the first instance the Government would pay from 50 to 100 per cent. more than the property is commercially worth; the economy arising from unity and centralization of management would be more than counterbalanced by the want of economy in the purchase, use, and sale of stores; the Government must either manage vast factories for making and repairing engines, carriages, and all the complicated machinery of the permanent way, or it must be continually buying by contract and selling waste stores again, with the pecuniary advantages familiar to us in the case of the Admiralty Department. In planning extensions it must stir up all kinds of local interests to intense agitation and competition, and all the struggles of the Committee-rooms would be repeated in another and perhaps a more corrupt form. In adjusting claims for compensation, whether for lands taken for extensions, for patent rights appropriated, or for personal injuries suffered, great difficulties would arise; the probability is, judging from experience in like matters before, that the landowners would get as exorbitant prices as ever, while the patentees and the unmoneyed persons would go to the wall. The Post Office *never* pays compensation, even for the loss of registered letters, and the Telegraph Department is following the same principle in disclaiming all pecuniary liability for negligence or accident in the performance

of its work. The public, though it could not enforce private claims, would expect all sorts of remissions of charges, just as it is now urging upon the Telegraph Department the reduction of charges to 6*d.* per message. The Railway Minister would be the rival in importance of the Chancellor of the Exchequer, and it would be impossible for him to bring forward a budget showing a satisfactory surplus without raising clamours for the remission of railway taxation, as it would be called. In the complication of the accounts the Railway Budget would far surpass that of the ordinary revenue and expenditure, and would deal with larger sums of money. Unless these accounts were kept in a manner very different from those of any Government Departments yet known, difficult questions about capital and current expenditure would creep in, and doubts would arise as to the real financial position of the greatest property ever put under the management of a single man. Royal Commissions and Select Committees would sit from time to time to endeavour to seek out the truth, but unless their success was much greater than that of similar bodies which have enquired into other branches of the public accounts and expenditure, they would not save the financial condition of the railways from falling into confusion. No English Government Department has ever yet, I believe, furnished a real balance-sheet, showing the actual commercial results of a year's work, with allowance for capital invested, unless it be the Post Office, which, as I have said, has little or no capital expenditure to account for.

Such would be the character of the results to be expected from State purchase of the railways, judging

by experience from the other branches of administration most closely analogous. It is, of course, impossible to say exactly in what degree each particular evil would manifest itself, and there would, no doubt, be some considerable national advantages to partially counterbalance the evils. What I wish more especially to show in the remainder of this Essay is, however, that the great advantages expected from Government management are of a chimerical character. The argument that men and women and trunks can be posted about like letters, is akin to that which leads a man every now and then to jump off his own house-top, because, as it is a mere question of degree, he ought, with suitable apparatus, to be able to fly like the birds.

One of the principal advantages to be gained from the State purchase of railways, in Mr. Galt's opinion, is a great reduction of fares, perhaps to a third of their present amounts. As this reduction would lead to a great increase of traffic, probably three times that at present existing, the trains would be much better filled; he even holds that, with the economical arrangements which a Government Department would adopt, this threefold traffic might be conducted with an *absolutely smaller* number of trains than run at present. The only point admitting of serious controversy in this scheme concerns the average number of passengers now carried in a train. An interesting discussion arose several years since in the *Times* upon Train Weights, and it was shown by Mr. B. Haughton, of the engineering staff of the London and North-Western Railway, that for every ton of passengers carried in a train

there are twenty tons of dead and non-paying weight; even in the goods traffic the train weighs more than twice what it conveys. The question thus raised is partly one of mechanics, partly of traffic management. If safe and durable carriages of less weight could be constructed, a great saving would doubtless arise; but I see no reason whatever to suppose that a single Government office would be likely to effect improvements in mechanical construction which all the competing, dividend-earning companies, with their talented engineers, have been unable to effect.

There only remains, then, the question of filling the present trains much more full of passengers. The average number at present carried in a train is no doubt remarkably small. In 1865 Mr. Galt stated that the average number of passengers carried by each train was 71, or, including season-ticket holders, probably about 74. Excluding, however, the summer excursion traffic, he thought that the real average of the ordinary traffic was not more than 50 per train, and the chief ground of all his plans was the suggestion that, instead of 50, an average of 150 passengers might easily be carried in each train, without any appreciable extra cost.

The advocates of low fares seem entirely to forget that a train must be provided to accommodate the maximum, rather than the minimum, number of passengers. Passenger traffic is a most fluctuating and uncertain thing; the state of the weather, the season of the year, the days of the week, the occurrence of markets, fairs, races, public meetings, holidays, excursions, and events of all kinds, affect the numbers

who travel by any train, and it is not within the powers of human wisdom so to vary the capacity of the trains from day to day that there shall always be sufficient accommodation, and little to spare. The difficulty is much increased by the necessity of consulting the comfort of passengers by providing three classes of carriages, distinct compartments for smokers and non-smokers, and especially *through-carriages* between important towns. A train thus contains, say, from five to twelve different kinds of passengers requiring distinct accommodation, and any passengers reasonably complain if they cannot find room in the kind of carriage for which they have paid, or if they have another class of fellow-passengers thrust upon them.

If it were the custom of railway companies to aim at filling their trains, the passengers would have to be almost indiscriminately mingled together; smokers and non-smokers would have to come to terms, through-carriages would have to be abolished, and, in fact, all that renders railway travelling tolerable would have to be relinquished. Moreover, when any accidental circumstance gave rise to a pressure of traffic, many passengers would inevitably be left behind at way-side stations. Now, men and women and children are not like goods, which can be laid aside for a few hours, or a day or two, until the pressure is over. They are greatly irritated and inconvenienced when delayed a few hours, and in the case of long pre-arranged journeys, or business engagements, detention from the want of train accommodation would be simply intolerable. In the case of omnibus traffic the vehicles can often be filled, because the distances are

small, and the passengers left behind have the alternatives of waiting a few minutes for the next omnibus, or taking a cab, or, if it comes to the worst, walking. Omnibus trains running short distances, such as those on the Metropolitan Railways, can be filled pretty well on the same system, and it is not uncommon to have to wait for the next train. Reasonable complaints are made at present concerning the unpunctuality of travelling, and occasional detention from the failure of correspondence between trains; but this is nothing to what would happen if any attempt were made to fill carriages, on an average, say three-quarters full. Cheapness of travelling is not the chief benefit of railway conveyance; we gain still more from its rapidity, safety, certainty, regularity, frequency, and comfort. Millions of journeys are made in Metropolitan Railway trains, in spite of the bad air, at a cost of *4d.* or *6d.* or *8d.*, instead of by omnibus for *2d.* or *3d.* or *4d.*, simply to save time and trouble.

In order to reduce fares in any great degree, without incurring bankruptcy, every kind of retrograde measure would have to be adopted. In place of frequent half-filled rapid trains, a smaller number of large, slow, crowded trains, stopping at many stations, would have to be adopted, as on many Continental railways. Frequent changes at junctions would have to be made by those travelling to great distances, and the loss in time, trouble, and temper would more than balance any gain in money. Cheapness is not everything.

One of the wildest suggestions which has been made is to the effect that uniform fares for journeys of every

length should be adopted. A gentleman proposed, I believe at a meeting of the Social Science Association, that passengers should be carried any distance at the nominal cost of 1*s.* first class, 6*d.* second class, and 3*d.* third class. He calculated that with a moderate increase of traffic this plan would produce a net increase of revenue of several millions yearly. Why not go a little further and carry passengers, like letters, for a penny stamp? Many people appear to have got a notion that there is some magical efficacy in low uniform rates, so that they are sure to produce a great net revenue. I can imagine no grounds for the notion except the great success of Sir Rowland Hill's Penny Postage. I believe it is the false argument from analogy again, that, because the Post Office pays with low uniform rates, therefore telegraphs and railways must pay under similar regulations. It would be interesting to learn how many persons, who in the present day admire and discuss the results of Sir Rowland Hill's reform, have ever taken the trouble to look into the original pamphlet, in which he demonstrated the practicability of a uniform penny rate. They would there discover that his scheme was founded upon a most careful and scientific investigation into the cost of collecting, conveying, and distributing letters. He showed that even when the mails were carried by coach the average cost of conveying a letter from London to Edinburgh was only one thirty-sixth part of a penny. He concludes:*—"If,

* *Post-office Reform, its Importance and Practicability.* By Rowland Hill. London, 1837. P. 19.

therefore, the charge for postage be made proportionate to the whole expense incurred in the receipt, transit, and delivery of the letter, and in the collection of its postage, it must be made uniformly the same from every post town to every other post town in the United Kingdom, unless it can be shown how we are to collect so small a sum as the thirty-sixth part of a penny." He advocated a uniform rate mainly on the ground that it was more nearly proportional to *cost price* than any other which could be levied, the costs of collection, sorting, delivery, superintendence, &c., being by far the most important items, and being the same whatever was the distance between the points of receipt and delivery. The same considerations apply, but in a somewhat less degree, to telegraphy. It requires but little, if any, more time to send a message a longer than a shorter distance. The terminal charges for collection, the time of the operator, and that of the delivering messenger still form a large part of the whole cost; but the varying extent of the wires employed, and the number of times the message has to be re-transmitted, create some difference between the cost of different telegrams.

In railway conveyance totally different conditions exist. The larger part of the cost of conveyance is proportional to the distance travelled, arising from the consumption of fuel, the wear and tear of the rolling stock and permanent way, the wages of the engine-drivers, stokers, guards, and other persons whose time is occupied, together with the interest upon the capital invested in the property which is employed. It is only the terminal cost of station accommodation,

clerks, porters, superintendence, &c., which are the same for a long and a short journey, and even these would not be the same if the passenger on a long journey had to change carriages often, requiring additional station accommodation, re-booking, assistance of porters, &c. It is quite absurd, then, to apply to railway passengers, each weighing perhaps, on an average, five thousand times as much as a letter, any arguments founded on Post Office economy.

Schemes of uniform charges are almost equally impracticable, whether the uniformity is to extend over the whole kingdom, or only over defined distances. In the former case the uniform rate must either be so high as to constitute a huge tax on locomotion over short distances, or so low as to form a great premium on long journeys, producing a vast financial loss, which would have to be borne by the people through general taxation. If the charge is to be uniform only between limits, one charge for distances under ten miles, another for all distances under fifty miles, and so on, the absurdity of the proposal is much less obvious, but the practical difficulties would be found to be insuperable. Arbitrary boundaries would have to be drawn round every large town, on passing which the fare would become much greater. Barriers, far worse than any toll bars, would be thus erected between town and country, and between one district and another.

One very plausible argument in favour of the transfer of the railways to the State is the profit which, it is represented, may be made out of the employment of public credit. The Chancellor of the Exchequer can

borrow money at about $3\frac{1}{4}$ per cent. per annum, whereas a railway company cannot borrow under 4 per cent., and the average return to railway investments is about $4\frac{1}{2}$ per cent. It seems, then, that by borrowing money at $3\frac{1}{4}$, and employing it in a business which, even when badly managed, pays $4\frac{1}{2}$, there would be a clear profit of $1\frac{1}{4}$, which, upon a property of the value of five hundred millions, would give a clear revenue of six millions and a quarter annually. Nothing, however, could be more fallacious and unsound in every respect than such suggestions.

The good credit of the English Treasury merely means that all the engagements will be paid. Railway companies are obliged to borrow on higher terms, because it is not sure that they will be able to declare dividends or pay interest on debentures when due, as many people have found to their cost. Now, if a Government Department undertakes to manage the railways they are bound to pay dividends, but unless they manage better than the companies they are likely to incur losses in some part of the business, which losses must be borne by the general revenue. The apparent net revenue of six millions and a quarter represents approximately the amount of loss to be expected. If the State manages the railways just with the same degree of skill and success as the companies, there would then be no gain or loss; if better, there would be gain accruing, not from good credit, but from good management; if worse, there would be certain loss. Thus, in theory, the use of the public credit proves to be a pure fallacy, and, if it were not so, there would be no reason why the Treasury should not

proceed to invest money in many kinds of industrial enterprises, besides railways and telegraphs.

When we come to look into the details of the financial operations by which the transfer would have to be effected, it will be found that loss is almost certain to every body of persons except the shareholders. It is not to be supposed that any shareholder will consent to have his income reduced by the sale of his property. Thus, a person holding 10,000*l*. in railway debenture stock, or good preference shares, paying say 4½ per cent., or 450*l*., will require at the least such an amount of consols as will pay the same annual income, namely, 15,000*l*., which, at the present market price, would be worth 13,800*l*. The operation must really involve a great loss to the State, because it gives a certain income instead of a somewhat precarious one. As a matter of fact, it can hardly be seriously supposed that railway property could be purchased at its present market value. All the ordinary stockholders would claim compensation for prospective gains, and during the discussion of the project there would be an enormous rise in the value of the shares. During the recent abortive agitation for the purchase of the Irish railways, the market price of the shares in one company rose from 8 to 37, and in other cases the rise was from 13½ to 37½, from 33 to 84, from 46 to 65, from 66 to 93, from 99 to 112, and so on.

Now, the railway shareholders of the United Kingdom are almost co-extensive with the wealthy and influential classes. Those Members of Parliament who are not actually railway directors are probably, with few exceptions, shareholders, and it cannot be

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expected that they would consent to any sacrifice of their legitimate interests. The actual value of such a property as the whole railway system is a matter of speculation, but whoever suffers in the transfer, we may be sure that it will not be the shareholders or debenture-holders. If we may at all judge from experience furnished by the transfer of the telegraphs, everyone interested in railway property should agitate for its purchase by the State as the surest mode of increasing his own fortune.

There is yet another fallacy committed by the advocates of State purchase. They assume that because the Government have borrowed several hundred millions of money at $3\frac{1}{4}$ per cent., therefore they can borrow six hundred or a thousand millions more at the same rate. Such an assumption is totally unwarranted, and is opposed to the undoubted laws of supply and demand. Because there is a certain demand for consols at 92 to the amount of seven or eight hundred millions, it follows almost inevitably that there would not be a demand for double the amount at the same price. There are a certain number of investors who prefer or require perfect security. To a great extent these investors are artificially created by the laws which oblige trustees and many public institutions to invest their property in the funds. There is another portion of the funds temporarily held by bankers, insurance companies, or other companies or persons having a floating balance of money. Other large portions are held by private individuals having a traditional attachment to the Three per Cents., or whose property has always been thus invested, and has

descended to them in that shape. Now, it cannot be supposed that if another National Debt, equal to that already existing, were created, it could be absorbed by the same classes of investors. The ordinary railway shareholder is a more enterprising person than the Government Annuitant. He would no sooner receive his share of the New Consols, equal in capital value to double the market value of his old shares, but paying the same or rather more annual income, than he would begin to think of getting 5 per cent. for his money instead of 3½. He would seek for home or foreign investments of somewhat the same degree of risk and profit as his old shares, and unless the funds had already fallen considerably, he would assist their downward course by selling out. The old fundholders, unless they had foreseen the course of events, and sold out in good time, would thus suffer a serious depreciation of the market value of their property, whenever they had to sell it, and it would at the same time be quite out of the question to admit any right to compensation on their part, as this would establish a right to compensation on any future occasion when the Government might need loans, and thus lower the funds. State purchase would then, as it seems to me, resolve itself into an enormous job, by which shareholders would make their fortunes at the expense of fundholders, and of operatives and other unmoneyed persons.

Coming now to perhaps the most important point of the whole discussion, I must remind the reader of the fact stated above, that the Government will gain or lose by the railways, according as it manages them better or worse than the present companies. There

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are a few so undoubted advantages in unity of organization, that, if not counterbalanced by the general laxity and want of economy in the care of Government property, a profit of some millions annually would thence arise. But in order that any such profit should continue to exist, the Government must work the railways at the rates which will pay best. It must make the railways a revenue department, like the Post Office, which takes care not to render its services at cost price. But the very writers who advocate State purchase, and tempt the public with glowing pictures of the profits to be thence derived, not to speak of the ultimate redemption of the National Debt, also tempt the public by promising a reduction of fares to a third of their present amounts. Now, these things are quite incompatible. If fares were much reduced, either the public must put up with very great inconvenience and discomfort in travelling, or else all net revenue must be sacrificed, and travellers must even travel to some extent at the cost of those who stay at home. We are told that there would be a great increase of traffic, and that, therefore, there would be a great increase of profits; but this argument is a complete *non-sequitur*, arising probably from false analogy to the Post Office business. In these days of high prices the butcher or coaldealer, who should sell his goods below cost price, would doubtless have an enormous business, so long as his capital held out. The railways would be in exactly the same position, except that they could carry on the process indefinitely by supplying the deficit out of the general revenue. Few people seem ever to reflect that postal communication stands in a very peculiar financial position, so

that to argue from it to other kinds of business is to commit the logical fallacy of inferring from the special to the general. Its chief peculiarity is, that an increase of work done will not occasion a proportionate increase of cost. If twice the number of letters are collected and delivered, the labour of stamping and sorting is nearly twice as great, but almost all the other expenses increase in a very minor degree. The mails are of so small a weight in general, that the cost of conveyance is but little, if at all, greater: this is true, at least, of the letters, though not so strictly true of the newspapers and books, which form by far the least profitable part of the postal traffic. Finally, the cost of distribution is by no means proportional to the number, because the additional letters will often be delivered at houses which the postman would in any case have visited, and it can hardly be said to be more laborious to deliver ten letters than one. When additional letters are delivered at houses previously receiving none, these houses will usually lie within the circuit of the postman, so that his labour and time in making the distribution will not be much increased. The more, too, correspondence increases, the more obvious this source of economy becomes. If every house in the kingdom received a letter every day, and there were no heavy books or other matter to load the men unduly, then as regards the mere distribution, apart from sorting, the very same postman could deliver twice as many letters with hardly any increase of cost.

In the case of the railway passenger traffic almost everything is different. Unless the comfort and certainty of conveyance is to be reduced, double the

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number of passengers must have nearly double the number of carriages, locomotives, engine-drivers, guards, &c. The station-accommodation must be much increased, and more porters, clerks, and servants generally must be employed. It may sometimes happen that double accommodation more than doubles the cost, because in large towns and other confined positions very costly engineering works may be required to give additional space. No doubt, when a line of rails is but little used, it may be made to do double the work, and thus pay nearly double profit. Many of the chief lines in the kingdom, however, are already so overburdened with traffic, that expensive precautions must be taken to ensure safety and efficiency, and an increase in that traffic involves a constant increase both of capital and current expenditure. This is the main difficulty in railway economy at the present time, and it will continue to be so.

Now, the railway reformers declaim at the same time against the extravagant expenditure of capital by the present companies and the high rates of charges. They do not seem to see that a reduction of charges would necessitate a further great expenditure of capital. It requires the utmost skill and care in the present traffic-managers to meet the strain upon the carrying powers of their lines occasioned by the progressive natural increase of traffic, and, if all the railways were managed by a few great officials in London, they would indeed require supernatural skill to carry, say a double or treble weight of persons and goods upon the same lines with equal speed and general efficiency. Yet this is what the railway reformers really contemplate and promise.

The general conclusion at which I arrive concerning the schemes of Government purchase is, that they are absolutely impracticable, and that the time, labour, print, and paper spent upon the discussion are wasted. Before I bring this Essay to a close, however, I wish briefly to examine the grounds upon which objections are raised to our present system. I feel sure that those objections are to a great extent erroneous, and that in many points the schemes put forward would greatly aggravate such evils as are at present existing.

There can be no doubt, for instance, that the punctuality of the passenger service has in the last two or three years been gradually growing less satisfactory, and much attention has been drawn to an apparent excess of railway accidents. I should like to see complete and accurate statistics of these accidents, and compare them with the amounts of traffic, before attaching so much importance to them as has of late been attributed to them by the newspapers. But taking, for the sake of argument, the worst view of matters,—to what are such unfavourable results due? There is absolutely no evidence that railway management is becoming more lax;—on the contrary, it is well known that the block system, and improved methods of signalling, are being gradually applied to all the lines of the kingdom; that the main trunk lines are in some cases being doubled; that stations and other necessary works are being extended at great cost; that the wages of railway-servants are in many cases being raised and hours shortened; the tendency at least, is always in the direction of improvement. How, then, do the results become worse? Simply, as I

think, because the ever-growing traffic is overtaking the capacity of the lines and works. The effect is felt during these years, partly owing to the general activity of trade, which increases all branches of traffic, and places money in the pockets of the people, enabling them to spend more freely in travelling, and partly owing to the introduction of third-class carriages into nearly all trains, which measure has amounted to a substantial reduction of fares and extension of accommodation. The simple fact is, that many parts of the railway system are already worked beyond their safe capacity. There are not a few stations where three hundred trains, or more, pass in the twenty-four hours. When waiting for a short time at some of the great junctions, such as those of Crewe, Chester, Willesden, &c., I have often wondered at the system of management by which trains are successfully loaded and despatched every few minutes, and traffic of the most complicated description is regulated almost without a hitch. But, if traffic continuously increases, there must also be a continuous increase of station accommodation, sidings, spare lines of rails, and other means of avoiding the interference of one train with others. It unfortunately happens that the reconstruction of great stations is a most costly work. The public would not be satisfied with stations outside of the towns, and the new stations are for the most part situated in the very centres of trade and city traffic, where land is enormously expensive. The London and North-Western have recently spent half-a-million in the enlargement of the Lime Street Station at Liverpool, and before long they will have to spend nearly as much in a

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thorough reconstruction of the Victoria Station at Manchester. In both towns other large and central stations are in course of construction. Of the vast expenditure upon the numerous large metropolitan stations it is hardly necessary to speak. Allowing that the cost of travelling is somewhat higher in this country than on the Continent, I hold that for what we pay we get, as a general rule; services unparalleled in excellence.

The conclusive mode of deciding, as it seems to me, whether railways are badly and oppressively managed in this country will be to enquire whether, as a matter of fact, people are deterred from travelling by railways on account of the cost and danger. Every institution must be tried by its results, and if our railways are so much worse conducted than those of other countries, the proof ought to be found in the smallness of the traffic. I do not find that any of the writers who complain about our railways have taken the trouble to ascertain the comparative numbers of railway travellers in different countries. In the time which is at my disposal for the preparation of this Essay, I have not been able to discover the number of railway passengers on the much-praised railway system of Belgium, but so far as we can judge from France the advantage is vastly on our side. I find that in 1869 there were 111,164,284 separate journeys on the French Railways, which, compared with a population of about thirty-eight millions, shows that each person on an average travelled not quite three times. Now, in the United Kingdom the number of railway passengers in 1867 was 287,807,904, which compared with 30,335,000, the

estimated population for that year, shows that every inhabitant of the United Kingdom travelled on the average almost nine and a half times, or more than three times as often as an inhabitant of France. The use of the railways, too, seems to be very rapidly advancing in this country; for in 1870 every inhabitant of the United Kingdom travelled on the average 10·8 times by railway, and in 1871, not less than 11·8 times. Moreover, in these calculations no account is taken of the unknown number of journeys of the holders of season and periodical tickets. Estimate it how we will, the state of passenger traffic in this country is very satisfactory.

People are fond of pointing to the Post Office as an example of the benefits of Government administration directed solely to the promotion of the public good; but between 1858 and 1870, the total number of letters delivered in the United Kingdom rose only from 545 millions to 863 millions, or by less than 59 per cent., whereas the number of railway passengers sprung up from 139 millions in 1858 to 336 millions, an increase of 141 per cent., being considerably more than twice the rate of increase of letters. If later returns were taken the results of comparison would be still more striking, owing to the recent great increase of third-class passengers. The Postmaster-General, too, lately discovered that he had been greatly over-estimating the numbers of letters delivered, the number for 1871 being stated now at 870 millions, instead of 915 millions as in the previous report. This vast error of 45 millions of letters, one of the largest errors I have ever heard of, does not increase our confidence in the Post Office

statistics, and we are not informed how many years are affected by similar errors. The result of comparison must be in any case to show that these much-abused railway companies, acting only, as it is said, for the benefit of their shareholders, have yet developed business far more than the much-praised Post Office.

Taking all circumstances into account, there can be no doubt that England and Wales are better supplied with railways than any other country in the world. The comparison is complicated by the fact that countries differ very much in the density of population, and, as truly remarked by Mr. Dudley Baxter, it is absurd to suppose that the mountainous and thinly populated districts of Wales, Scotland, the North of England, and Ireland, could be as closely reticulated by railways as the small, flat, densely-peopled kingdom of Belgium. Now the comparison of the area, population, and length of railways in the principal States of Europe gives the following results :—

	Population per square mile.	Square miles of area to each linear mile of railways.
Belgium	451	6
England and Wales	389	5
Netherlands	291	13
United Kingdom	265	8
Italy	237	27
Prussia	180	19
Ireland	169	15
France	150	19

We find, then, that England and Wales are better supplied with railways in the proportion of 6 to 5 when compared with Belgium, although their population is less dense in the ratio of 389 to 451. Combining these two ratios, we discover that the length of railways here

exceeds by 39 per cent. that in the best supplied Continental kingdom, regard being had both to population and area. This comparison is with respect to length only; if we looked to the comparative costs of the railway systems, which more nearly measure the difficulties encountered and the accommodation offered, the contrast would be far more striking. English railways cost about two and a half times as much per mile as those of the small kingdom of Belgium.

One of the chief complaints raised against the present state of railway conveyance refers to the high rates charged both for passengers and goods on British railways. Mr. Galt stated in 1866 that a person could travel 100 miles in a first-class carriage in Belgium for 6*s.* 6*d.*, in Prussia for 13*s.*, while in the United Kingdom it would cost 18*s.* 9*d.* The Royal Commission upon Railways carefully investigated this subject, and their conclusions only partially bear out Mr. Galt's statements. They found that the average rates of charge in the principal European countries are as in the following table, the numbers denoting in pennies, and fractions of a penny, the cost of travelling an English mile:—

	England.	France.	Prussia.	Austria.	Belgium.
First Class .	2·11	1·73	1·57	1·87	1·23
Second „ .	1·51	1·30	1·17	1·41	·93
Third „ .	·92	·95	·80	·94	·62

There can thus be no doubt that the fares are higher here than in any other Continental country, and compared with Belgium the excess is considerable. But the Commissioners point out that, before we come to any safe conclusion, other circumstances must be

taken into account. It is not usual to have to pay anything for luggage on British railways, whereas such charges are frequent and heavy on Continental railways. Considerable reductions are here made upon return and season tickets, which are seldom allowed abroad. It is also to be noted that the low first-class rates are often found to be delusive, as long journeys must almost of necessity be made in express trains for which the rates are higher.

We should also take into account the much greater average speed of English trains, and the much better accommodation (always excepting refreshments) offered in the English railway stations. Third-class passengers can now travel in express trains at fifty miles an hour for less than a penny a mile. In the comfort of the carriages, however, the foreign railways are before us.

Before we could really decide whether the cost of travelling in this country is excessive, we should have to compare the general cost of living here and elsewhere. If railway fares are high, it is also easy to show, indeed it is a common complaint, that the wages of operatives are high, that prices of provisions are high, that the cost of land especially is high. Except possibly in the case of the unfortunate agricultural labourers, all classes in this country are more highly paid and live at a higher rate than in other European countries, and under those circumstances it is quite to be expected that travelling should be somewhat more costly. Now, if the advocates of State purchase wanted thoroughly to establish their case, they ought to show that in spite of the higher cost of things in

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England, the English Government manages to carry out other branches of administration at a lower expense than other nations. But if enquiry were made into the cost at which we maintain a soldier or a sailor, it would be found that our Government pays a great deal more than any other European State. The profuse and uneconomical expenditure upon our army and fleet is a perennial source of discontent, expressed both in and out of Parliament. Some of this excess may be explained as due to exceptional circumstances in our position, but much is due to the essentially higher rates of salaries, wages, and prices in this country. Thus the late Colonel Sykes, in comparing the extent and expenditure of the English and French navies in 1865, pointed out * the greatly higher rates of pay and allowances to officers and men, and the greater cost of provisions and clothing in the English navy. Yet the same Government, which is always wasting money on its army and navy, is to work miracles of economical management in the vastly more extensive, complicated, and delicate system of railway conveyance!

I must say, in conclusion, that I am perfectly aware of many evils and abuses existing in our present railway system. The charges for the conveyance of goods appear to be excessive in many cases, and it is remarkable that the goods traffic has not increased in anything like the same ratio as the passenger or the mineral traffic. There can be no doubt, too, that the

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* *Journal of the Statistical Society* for March 1866, vol. xxix. p. 65.

arbitrary manner in which companies impose high rates where they have got the traffic safe, and lower them where traffic is to be attracted, gives rise to great grievance. It certainly seems to be quite intolerable that an almost irresponsible board of directors should be able to tax a town or a district after a fashion upon which the Chancellor of the Exchequer could never venture. The rates for the carriage of parcels, too, are very excessive and arbitrary; the whole of the arrangements, indeed, for the transmission of small goods in England are in a chaotic and utterly absurd state. It is in this direction, I believe, that the next important measure of Government management ought to turn.

I do not for a moment wish to assert that any railway company has acquired such right to a monopoly that it may go on indefinitely charging the public at unreasonable rates, nor do I think it right that a company should be allowed to make excessive profits from some portions of its lines to counterbalance the loss upon other portions. My argument is to the effect that the present companies do on the whole render better services to the public than those of any other railway system which can be brought into comparison with ours, and at charges which are, when all circumstances are taken into account, as low or lower than those elsewhere existing, as proved by the great numbers who do travel by railway. But in whatever points exceptions to this favourable state of things can be shown to exist, Parliament ought to apply strong remedies. The appointment of Railway Commissioners by the recent Act is a step in the right

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direction. If their powers are found to be insufficient to enable them to control the companies and prevent them from inflicting injustice, then their powers must be increased until they can carry out efficiently the purposes for which they were appointed. It is by applying ourselves to devise and create a judicious system of control and reform in details, and not by chimerical schemes of Government purchase, that we may really hope to improve and cheapen railway communication in the United Kingdom.

W. STANLEY JEVONS.

XIV.

The Peace of Europe.

Political phrases, like everything else which is of human origin, have their day. If the nicknames of one generation are worn with pride as party badges by another, the watchwords of the popular politics of one century not unfrequently become the bye-words of its successor. Expressions in which our ancestors summed up what seemed to them established results of historical experience or cardinal maxims of political conduct, we as of one consent proclaim hollow and delusive; it is only our own devices which give a solid sound, and we confidently ring the changes on them accordingly.

Thus the once famous expression of the *Balance of Power*, which pervades the English political oratory and literature of the eighteenth century, is now, as may be read by him who runs, regarded by general consent —at least in our own country—as signifying nothing but an exploded fallacy, a self-betrayed unreality. "The English and the Americans," says M. de Laveleye, the eminent publicist, to whose recent very striking work* I shall make more than one reference in this Essay, "only speak of the Balance of Power as of a super-

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* *Des causes actuelles de guerre en Europe et de l'arbitrage* (1873).

annuated idea, inapplicable to the nineteenth century." "This chimera, 'the balance of power,'" is the contemptuous phrase of another recent writer;* but, then, unlike M. de Laveleye, who gives the only definition of the term which conveys any historical meaning to my mind, he has previously defined the maintenance of the balance of power to consist in preserving (by force of arms, if necessary) the exact relative positions of the European States actually existing at the time. I mention this definition, and the conclusion drawn from it, in order to suggest how easy it is to argue from one's own definitions. If the balance of power had ever been intended to mean the preservation at any cost of the precise existing positions of the States of Europe, it might certainly prove less difficult to show how long that balance endured than to point out when it was first established.

As M. de Laveleye, on the other hand, explains the term, and as (to cite a much earlier writer) Hume, in his well-known Essay *On the Balance of Power*, evidently understands it, it expresses a principle of policy so simple and so obvious, that with or without the name the underlying idea has existed, it may almost be said, ever since history has been written. The only question is as to its applicability to the political relations among any given group of States, those of Europe for example.

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* Mr. Augustus Mongredien, *England's Foreign Policy* (1871). This Essay, together with numerous other pamphlets and papers, was obligingly communicated to me by the Secretary to the London Peace Society, whom I have every reason to thank for his courtesy to a stranger and sceptic.

Without any forced ingenuity, Hume endeavoured to trace a consciousness of the principle involved in the phrase in the political world of ancient Greece. No exception is to be taken to his illustrations, unless it be necessary to remark that hereditary jealousy—as between the Athenians and the Thebans—and that spirit of rivalry which was as the very breath of life to many of the Greek commonwealths, exercised an influence as important as that of any political principle. The study of the policy of Athens before and after the battle of Leuctra, is specially instructive as exhibiting the inevitable weakness of a people which is guided by its prejudices rather than its interests. But the real political capacities of Greece, a Brasidas, an Alcibiades, a Demosthenes, well understood the principle; and one of them (as Hume observes) taught it to Persia.

The political history of the Roman Empire moved within far wider limits than that of the Greek commonwealths. In the West* the principle of the balance of power was doomed to a long period of suppression, as Rome gradually became omnipotent in the territories forming the main theatre of classical history. She had obtained the mastery over Italy because the variety of races inhabiting it—Gauls, Greeks, Etruscans, and Italians—had rendered combination against her

* For it is of course true, as Mr. Cox remarks (*History of Greece*, i. 167, Note 332), that stress has rightly been laid (by Mr. Rawlinson, in his *History of Parthia*) on the fact "that at no time was a check wanting to Roman power in the East, and that for three centuries this check was supplied by the Parthians." At the same time it is difficult to agree with Mr. Cox that "the importance of this balancing power is not lessened, even if its effect be not felt everywhere."

out of the question. As her power progressed, the vastness of her ambition became itself an element of safety. The genius of Hannibal alone, the one truly great foe whom Rome had at any time to fear, was equal to the conception of a Grand Alliance which might have prevailed against her; but the danger passed away. Philip of Macedon was finally bought off by a treaty which the Roman Senate was sure to break as soon as it should have crushed Hannibal;* and clinging with aristocratic tenacity to an accepted maxim of policy, the oligarchs who established the universal supremacy of the Roman Republic achieved this result by the system of *divide et impera*, which is the direct negation of the negative implied in the principle of the balance of power.

From the Great Popular Migrations arose the beginnings of that body of nations which we designate as the European family. The term is offensive to philosophic ears; I grant it to be loose in every sense, as it is variable; but it commends itself as implying very little more than it actually means. It did not include Russia in the Middle Ages; at the present day its geographical exactness is sufficient. It by no means necessarily involves a community of race, of civilisation, even of religion. It simply means a group of neighbours. The truth of Hesiod's maxim has never been considered parodoxical: that a bad neighbour is a great evil, and a good neighbour a great advantage. On this principle nations as well as men have always found it advisable

* Appian. ix. 2: καὶ τὰς συνθήκας οὐδέτεροι βεβαίους οὐδ' ἀπ' εὐνοίας ἐδόκουν πεποιῆσθαι. Cf. Ihne, *Röm. Gesch.*, iii. 2. Philip's suicidal selfishness has more than one parallel in the history of alliances.

to act.* The relations between the nations and States of Europe have accordingly always been of primary importance to the nations and States in question. The peace of Europe is not identical with the peace of the world; but it is absurd to deny that the former is, and always has been, of primary importance to European peoples.

So long as any vestige of real authority remained to the so-called Roman Empire of the Middle Ages, the endeavours to resist the predominance of the German Kings who sought to assert a general supremacy under the pretext of its venerable name were mere attempts —frequently aided by the conflicting assumptions of the Papacy after its claims had become dissociated from those of the Empire—to preserve or establish territorial, municipal, or national independence. Neither the struggles between the Emperors and the Popes in general, nor the various combinations against the Hohenstaufen Emperors which accompanied them in particular, can, however, be said to have been based on the desire to establish a permanent system of mutually acknowledged rights and boundaries. And theoretically, either the supremacy of one Power was acknowledged or that of another was asserted. Such, however, is the influence of ideas, especially where they are of an imaginative rather than a logical character, that Western Europe had to struggle for centuries before it was virtually emancipated from the results of Otto the Great's ambition. Fictitious in

* The Russians, *e.g.*, whose diplomatic relations with their *neighbours* have always been, in one way or the other, of a most active kind.

conception and false in fact, the Roman Empire of the Germanic nation was doomed to inevitable extinction.

But the modern State-system of Europe had to be formed in its main component elements before it could seek for external as well as internal guarantees of its endurance. Thus it may be asserted that the European State which first unsettled the position of things at the beginning of the period which the school-books call Modern History, was the first State which brought about an endeavour to establish the balance of power. In other words, by exhibiting herself as the main danger to the preservation of the existing relations between the European States, France first suggested the conception of a general alliance in the interests of the common security of her neighbours.

It was the active genius of Italian statesmen, the inheritors of the political genius as well as of the culture of ancient Greece* which, in order to resist the encroachments of France at the close of the fifteenth century, extended a system of policy, long pursued in the internal conflicts of Italy itself, to the relations between a considerable number of the European States at large. Nothing can be drearier and in detail less interesting than the narrative which, in his *History of Florence*, Macchiavelli gives of the endless jealousies and petty struggles between his native city and Venice, and the Popes and other Italian Powers. The "balance of power" which they attempted to preserve was

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* Mr. Freeman has dwelt on this from other points of view, in his suggestive Essay on *Ancient Greece and Mediæval Italy* (*Historical Essays, Second Series*).

nothing more than the casual result of a selfishness often intensified an by inter-municipal envy, to which the Greeks themselves hardly sank in so deplorable a degree; but the great league which drew Charles VIII. out of Naples was a legitimate combination of conservative elements in and out of Italy against a permanently disturbing element, the conquering ambition of the House of Valois.*

The great duel between France and the House of Habsburg in the sixteenth century was, as between the main combatants, of course a mere contest for supremacy in Europe;† but other States, England among the number, sought to influence the successive stages of its progress so as to make impossible the permanent predominance of either. The policy of Wolsey lacks neither intelligibility nor intelligence; but its zeal was excessive, and neither he nor his master knew—perhaps could know—the real measure of their country's resources.

* Among the founders of this league (between Spain, Venice, the Emperor, the Duke of Milan, and the Pope) was Alexander VI. With all their vices, the genius of the Borgias was that of statesmen of the highest order, and one which might have made Italy great and free, could nations be made great and free by statecraft. As to the character of the ambition of Charles VIII. (by whose side even Otto III. seems a respectable imitator of Charlemagne), see Sismondi's *Italian Republics.*

† There is something almost *naïf* in the way in which the rivalry of France, even in the matter of Church reform, is resented by a German correspondent of the Roman King, towards the close of the fifteenth century: 'daraus ich sorg, der Küng von Frankrich werd auff das mindest die Kirchen reformieren und damit ihm selbs in aller cristenheyt lob eer vnd auffseehen machen, das doch E. Ko. Mt. von göttlichem vnd weltlichem rechtem me zů gefüret denn jm' (Marquard Breisacher to K. Maximilian, 5th January, 1495, in Chmel's *Urkunden*, &c., p. 56).

When the religious strife of the same century added a totally new element to the calculations of statesmen, when France was weakened by a division of many complications,* and Spain was temporarily strong in enforced unity, the danger to the balance of power from this new quarter assumed an unmistakable character. It needed the great Protestant combination, of which Elizabeth reluctantly became for a time the head, to remove the pressure of an intolerable incubus. Henry IV. of France, who owed his throne in no small degree to the operation of this reaction, was too anxious to retain a secure seat upon it to allow the daring schemes with which he has been credited, to approach realisation within his life-time.† So long as the House of Habsburg left the security of its neighbours in peace, there was no likelihood of a serious effort on the part of the Protestant interest to unsettle the existing system. The combination which just before his death threatened the outbreak of a general war was caused by a difficulty which the policy of that House had deliberately prepared, and sought at the critical moment to use for the interests of its own ambition.‡ But after Henry IV.'s untimely death,

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* For in the great civil wars of France there were arrayed: Calvinism against the authority of Rome, the principle of monarchy against that of aristocratic cantonal government, the principle of national self-determination against the prejudices of the capital, a free France against the tutelage of Spain.

† The so-called "Great Plan of Henry IV.," to which reference will be made below, was at the most held in readiness for contingent use.

‡ *i. e.*, the clash of claims to Jülich-Cleve-Berg was the consequence of the cancelling by Charles V. of the heritage treaty of 1544; and

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his country was once more paralysed by intestine struggles; and the power of England, half-fledged, was crippled by the first serious symptoms of similar influences, and by the impotent timidity of a hopelessly self-confident prince. James I. balanced nothing but his own wit, and even that with indifferent success.

Thus, religious fanaticism once more nerving the arm of dynastic ambition, the same danger once more arose in the same quarter; and the House of Habsburg once more sought by a combined effort of its branches to master the lands and the shores of Europe. This attempt, which belongs to the earlier part of the Thirty Years' War, had been near success; no sword has ever redressed a balance more promptly and more decisively than that of Gustavus Adolphus; and the remainder of the long-protracted conflict was nothing but a struggle for the details of a peace as to the essential conditions of which no doubt could exist.

Contemporary with the failure of the House of Habsburg, and at first a secret, then an open, cause contributing to that failure, had been the rise into new vigour—the "rejuvenescence" as it has been termed *—of the power of France. The indefatigable energy with which Richelieu had consolidated the monarchy is not more remarkable than the politic self-restraint with which he delayed the moment of intervention in the affairs of Europe. In the Peace of Westphalia his

the Archduke Leopold was the real "ferret in the rabbit-warren" of the contested duchies. (Cf. as to this phrase Motley's *Life of John of Barneveld*, vol. i. p. 66.)

* By C. v. Noorden in his *Europäische Geschichte im* 18. *Jahrhundert*, a work of singular lucidity and breadth, so far as I can judge from its first volume.

successor obtained for France, besides gains of territory, bases of pretexts and opportunities for new acquisitions; in the Peace of the Pyrenees, which crowned the policy of Mazarin, the western branch of the House of Habsburg had likewise to acknowledge its defeat.

It was only in the earlier part of the Great War that the voice of England had been feebly, her arm even more feebly, raised to influence the course of the struggle; by the time of the Peace of Westphalia she had ceased to be taken into account. When her strength was gathered in the mighty grasp of Cromwell, the political sagacity which he almost invariably exhibited ranged her arms on the side of France; and Holland was forced to follow in her wake. One of the last diplomatic attempts of Cromwell was to second Mazarin's efforts to prevent the succession of a Habsburg prince to the imperial throne.*

How Cromwell would have borne himself towards the change in the aspect of European affairs which ensued by the conclusion of the Treaty of the Pyrenees, it is needless to speculate. His foreign policy had been essentially his own; and his most marked political characteristic was a swift and resolute recognition of fact. The chief importance of this treaty, and the chief motive why France had consented to it, was the marriage of Lewis XIV. to the eldest daughter of the Spanish king, which secured to the French monarch the basis for a future claim on the Spanish inheritance. Of course, the claim was expressly renounced, but prac-

* Ranke, *Englische Geschichte*, vol. iii. p. 567. Leopold I. was, however, elected, chiefly in consequence of the exertions of Brandenburg.

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tically it survived as a danger for the future. When, soon afterwards, Lewis himself assumed the reins of government, the epoch of preparation began for the great attempt of France to assert her supremacy—nothing short of this—over Europe. His intentions were, generally, to acquire territory wherever France had frontiers, *i. e.* to annex parts of the Netherlands and of the Empire, and specially, when the opportunity arrived, to unite with the French Crown the monarchy of Spain. The former is the more directly significant, though the latter proved the more widely momentous, part of his policy. France bore herself as a standing menace to the peace of Europe.

The policy of England towards France in this period was uncertain, for the simplest of reasons. The instincts of the people pointed in one direction, the desires of the Court in another; while the machinery of government was neither such as to enable the Sovereign permanently to override the wishes of his people, nor sufficiently developed in a contrary direction to make his counsels amenable to their influence.* Sir William Temple, one of the truest friends of a genuine peace-policy whom England has at any time numbered among her statesmen, temporarily defeated the designs of France upon Holland by one of the boldest treaties ever consummated by our diplomacy. The Triple Alliance maintained peace by holding war in reserve. But the fatal course of Stuart policy, tenaciously directed towards its own ends, undid the alliance; and after

* It was in this direction that Temple's famous scheme of Cabinet reform (1679) was intended to operate. (See Macaulay's *Essay on Sir William Temple.*)

new French encroachments the Treaty of Nymwegen only in so far constituted a check upon French ambition that in sanctioning new French acquisitions it prevented the immediate seizure, by force direct, of more. Europe had paid another Danegeld.*

Then commenced those *reunions* (the word has fallen out of political use, the nineteenth century preferring the term *revindications*) which the Eastern difficulties of the Emperor obliged him to suffer. While in futile self-dependence he was entangling himself in secret treaties with his ruthless adversary, and escaping from them when he found them broken reeds, England was, unknown to herself, bound hand and foot by another secret engagement between her Sovereign and his French patron. A net of French intrigue had—literally—been spun around Europe from the Straits of Dover to the Bosphorus; and there was nothing to stop French aggression, which, all future designs apart, freely extended itself towards the Rhine, across the Alps, and into the Netherlands.

So far, then, as the maintenance of the balance of power signifies an endeavour to resist—in the only way in which it can be resisted—the encroachments of a neighbour of overbearing power and ambition,† it must

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* To the Triple Alliance may perhaps be compared the treaties concluded by two other Whig statesmen: the Quadruple Alliance of 1718, which virtually disposed of the ambition of Spain, and Lord Palmerston's Quadruple Alliance of 1834, which he not less truly than characteristically described as "a capital hit, and all his own doing."

† "The aim of modern politics," says Hume, in his *Essay*, "is pointed out in express terms in a maxim of Polybius: 'Never ought such a force to be thrown into one hand as to incapacitate the neighbouring States from defending their rights against it.'"

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be conceded that the adoption of this principle had in Europe from the close of the fifteenth to the close of the seventeenth century been not so much a political theory as a political necessity. To maintain this balance had, in the struggle of Italy against France, in the struggle of the Protestant Powers against Spain, in the struggle of Northern Germany and the United Provinces against the House of Habsburg, and now again in the struggle of the Netherlands and the Empire against France, been to obey the dictates of that law of self-preservation which no political theorist* has ever denied to be binding upon States and nations. There is no law—unless there were one of religion absolutely prohibiting the use of arms—which can override it. And since combination can alone render resistance successful on the part of the weaker against the stronger, combination for such a purpose was as legitimate as it was inevitable.

But this rapid sketch has brought me to a period in European history when it was first sought to establish the security of the peace of Europe on a more permanent footing, and to make the balance of power an enduring reality established by settled guarantees. Still, the end proposed was no other than that which the successive combinations of two centuries had pursued; and, so far as the end is concerned, the policy of William III., the incarnation of the much-decried system of the balance of power, has the same justification as the policy of Venice, of William the Silent, of

* Except, of course, those who reject altogether the binding character of State-ties, and accept only those of a commune, or of still narrower associations.

Protestant Germany, and as that of William himself, when he first stood forth as the leader of his countrymen in their desperate struggle against their overbearing neighbour.

Beyond all doubt it was not in the spirit of a crusader for constitutional rights (which as worked by the "constitutional party" of his reign, the Tories, with their patriotic objection to standing armies, were to give him no little trouble) or for the sacred cause of civil and religious liberty all over the world (though he understood the meaning of the latter term much better than the bulk of either Tories or Whigs*) that William of Orange accepted the invitation to ascend the English throne. His motive was the preservation of the independence of his native land. Yet no political necessity of his own would have justified him in causing England, or England in consenting at his bidding, to assume the attitude which she gradually took up towards the aggressive power of France. The reluctance and recalcitrance were the reverse of slight which he had to evade or overcome; but it was the duty of England to take part in the Grand Alliance which it became the object of his life to knit. For the attempted intervention of Lewis XIV. in her own affairs had been no panic-stricken apprehension, but a well-established reality. It is, I confess, with little patience that one can see doubts thrown upon the wisdom or justice of a course of policy which was that of self-preservation pure and simple. Not only our

* As witness the Treaty of Limerick, and William's hesitation in taking the Scotch Coronation Oath.

constitutional life, which Charles II. and James II. had already begun successfully to undermine and which they were plotting with French help to overthrow, not only the maintenance of that freedom from foreign ecclesiastical control which indubitably the great body of the nation had at heart, but our national independence in the literal sense of the term was in danger from the league between the Stuarts and Lewis XIV., of which force had from the first been intended to make a victorious combination, which force proved to be a reality after the Revolution, and which force—combined force—could alone successfully resist. It is not party zeal or national prejudice, but the calm verdict of historical criticism which asserts that the danger to England's freedom and England's power of self-determination—without which no national life is worth a day's purchase—from Holland's greedy neighbour, was as real and as imminent as the danger which had threatened both communities from Spain in the days of the Revolt and of the Spanish Armada.*

William perceived—what his Parliament (in the unworthy attitude assumed by it in the debates on the

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* It is, of course, out of my power to prove the above proposition within my present limits. But attention may be directed, as to principal links in the chain of evidence, to the Secret Treaties of 1670 and 1676, and to the negotiations between Lewis and James early in 1688, described by Ranke at the close of his fifth volume. See also the very remarkable account of Bentinck's interview with the Brandenburg Privy Councillor, von Fuchss, *ib.* p. 529 *seq.* As to the conduct of France after the Revolution, the facts speak for themselves. And the recognition of "James III." in 1701 was only the open declaration of an attitude which amounted to that of a claim to suzerainty.

Partition Treaties*) virtually refused to see—that the question of the Spanish succession and of the frustration of the designs of France upon it, was intimately bound up with that of the independence of both Holland and England from France. The military power of Lewis, in other words his power of resuming a policy of aggression, had not been broken by the Peace of Ryswick, in which the question of the succession had been studiously avoided, and which was therefore essentially a mere truce. To allow this Power—directly or indirectly—to acquire the whole of the inheritance of Charles II. was a danger as palpable as it must soon become imminent. Neither was it desirable to allow the whole to fall to the Austrian candidate, and thus to raise a single branch of the House of Habsburg to a dangerous predominance in Europe.

In his Partition Treaties, the execution of which was frustrated by circumstances beyond the control of statesmanship,† and afterwards in the war which he bequeathed as a legacy to the inheritors of his policy, William endeavoured to obviate both dangers by a division of the Spanish monarchy. This simple fact is not always remembered by those who identify the later (and in my judgment unjustifiable) policy of Marl-

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* Unworthy, because whatever may be thought of the policy of the Treaties, Parliament had by reducing the army made it impossible for the king to use any means but those of conciliatory negotiation.

† Viz., death (that of Joseph Ferdinand) and intrigue round the deathbed of an impotent old man (Charles II.'s last will was ascribed to the personal influence of the French envoy, Harcourt). But the Second Treaty had never been assented to by the Emperor, and it is not wonderful that Lewis should have rejected it in favour of the will.

borough with that which he inherited from William. But was the principle which William thus sought to carry into practice reconcilable with the inevitable canon of all political conduct, viz. the laws of morality? Fénelon impressed upon his royal pupil the maxim on which William acted, that "a particular right of succession or donation ought to yield to the natural law of security for many nations."* Surely to this ought to be added the safe-guarding condition: "provided always that the consent of the people whose destinies are involved, be secured."† In the case of the Spanish succession William was probably as little disturbed by the omission of any references to the wishes of Spain as Lewis himself, and disregarded the protest of the Spanish Government (in which it doubtless spoke the wish of the Spanish people) against the proposed dismemberment of the monarchy. The defence of his policy lies not so much in the fact of the strong pressure of necessity, as in the consideration that the Spanish nation and the Spanish monarchy were not convertible terms. No national life is a legitimate subject of annihilation; but it seems a maintainable argument that an artificially accumulated State may be dismembered for the benefit of the group of nations to which

* Quoted by Wheaton, *History of the Law of Nations*, p. 83.

† Thus, *e. g.*, when in the once famous treaty of 1852 the Great Powers altered the succession in the Elbe Duchies, the measure, whatever its merits, remained incomplete till the assent of the Duchies themselves (through their estates) should have been obtained; and the absence of this assent, it was afterwards justly, and one would have thought intelligibly, argued, rendered the treaty nugatory in international law, which must be based on the principles of international morality.

its members belong, if their continued union endangers the security of the rest.* I do not forget the Emperor Nicholas; but granting that his scheme was in itself a desirable one, his political wrong lay in attempting to carry it out, first by a conspiracy, and then by force.

It is at the same time true that the War of the Spanish Succession was afterwards carried on for a changed end. The same error was committed, *mutatis mutandis*, with perhaps less excuse, in the great war against the French Republic by the younger Pitt. The object, and if the above argument be accepted, the legitimate object, of the War of the Succession was to prevent the power of France from obtaining the undivided Spanish inheritance; but at an early stage of the war England definitively bound herself to uphold the claims of the Austrian candidate. So in the later war with France, the legitimate object with which it was undertaken or (to speak more correctly) accepted, was to resist the aggression of France beyond her frontiers; but with this was afterwards combined another object which Great Britain had no claim to help in securing, viz., the restoration of a particular dynasty to the throne of France. And the ambition of Marlborough carried him to even more

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* I am glad to find this view corroborated by v. Noorden, who (taking exception to the Partition Treaties on other grounds) observes (p. 112): "It was by no means a question as to the dismemberment of a national life (*Volksthum*); not even Aragonese and Castilians, much less Spaniards, Neapolitans, Milanese and Netherlanders, were united by a national-political idea; the dismemberment of the Spanish monarchy, to whatever degree it might wear the aspect of an act of force, was excused by the need and the welfare of the world of that age."

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unwarrantable lengths, when he continued the war with France, even after she had consented to renounce the support of Philip V.*

Shortly before Marlborough's fall, the death of the Emperor Joseph I., whereby the titular King Charles III. of Spain became master of all the Austrian dominions, altered the whole aspect of the question. If the Spanish monarchy were in its entirety secured to him, the balance of power in Europe would once more be seriously threatened, though in an opposite direction to that which the efforts of Great Britain had hitherto sought to meet. It was, however, the result not of the original policy of William and the war—not of the policy of the balance of power proper—but of the imprudent and unjustifiable engagements taken after his death, that British policy thus found itself in a false position, from which it could only extricate itself with loss of honour.

A candid review of the conditions of the Peace of Utrecht, into which I have no space to enter, will show that no view of it could be less just than that

* This was in 1709; but already in 1706–7 France had made offers which it was in the interest of Great Britain to induce the Emperor to accept. Marlborough's conduct in 1708–9 seems to me indefensible, although it is true (as urged by Archdeacon Coxe) that Marlborough was ready to waive the condition on which Godolphin insisted. He gave way to his party against the wishes of both the sovereign and the majority of the nation; and yet the Whigs had only become his party because their support had enabled him to carry on the war. But as infinitely the most influential man of the party, he must bear the chief responsibility of its policy. The same remark applies *à fortiori* to the negotiations of 1710; for I cannot agree with the historians (Lord Stanhope, *e. g.*) who suspect the sincerity of Lewis XIV. at this particular point of time.

shrilly proclaimed by the Whig writers of the day: how in it British interests had been sold to France. If Cato could have told the truth to his friends of either party, he might have informed the Whigs that they had been careless of the true interests of the country, and the Tories that they had made light of its pledged honour. But had Great Britain not been legally and morally bound by engagements which it had never been her real interest to form, the conclusion of the great war of the Spanish Succession (which virtually secured the objects for which it had been undertaken) would be as justifiable—and on the same grounds—as was the opening of it.

For nearly a century,—until the generally aggressive ambition of France once more essayed, this time in the name of Freedom, to change the face of Europe, the Treaties of Utrecht remained the established basis of the relations between its States. The Quadruple Alliance of 1718 and the war against Spain of 1719 enforced the policy of Utrecht with remarkable promptitude and effect; and though the diplomatic history of this Alliance (and of the Triple Alliance preceding it) has its shady sides, the results of the foreign policy of Stanhope and Dubois were thoroughly consistent with the interests of the European system. Doubtless there were many other wars in this century; but the several congresses which terminated them re-established general peace with comparatively little trouble, and without necessitating any unsettlement of the territorial stipulations of the Utrecht treaties in any intrinsically important point.*

* The complicated arrangement at the Peace of Vienna in 1738,

The War of the Austrian Succession, which led to the Second Silesian and to the Seven Years' War, was the result of an aberration, brought about by the restless eagerness of Austrian diplomacy, from the accepted principle of *joint action* on the part of the European Powers in reference to any question seriously affecting their mutual relations.* The only definite result of these wars was the sudden rise of Prussia to the rank of a Great Power; but the aggression which, under hypocritical pretences, Frederick II. dared in the first war, and the acquisition which he heroically defended in the second and third, in no wise affected the security of any of the allies of himself or of his adversary. The transfer of Silesia having been accepted by Austria, was accepted by Europe; and the attempted unsettlement of the cession only led to its final establishment. The slight shock given to the European system by the original aggression was of less significance than the attempted retaliatory dismemberment of the Prussian monarchy, an intrigue

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whereby Lorraine eventually fell to France, may be mentioned as an exception. German patriots have since discovered that their nation never forgave the House of Austria this act of national treason.

* It seems to me that the engagements into which many European Powers had been induced to enter with Austria to uphold the Succession as settled by the Pragmatic Sanction must be condemned as prejudging a question which foreign Powers had no right to discuss unless they discussed it collectively in the interests of the peace of Europe at large. The fact that these engagements had been taken *separately*, and that they were in consequence observed by some and cast to the winds by others, without there being any mutual right of holding one another to the guarantee, caused the wars mentioned in the text, which temporarily disturbed the peace of Europe, but cannot be said to have endangered it as a system capable of re-establishment on the same basis, to which indeed it finally attained.

concocted in the dark of which the consequences were averted by Frederick's heroic energy and endurance. Though his career did not end without his devising a scheme to secure himself and his brother-princes against Imperial ambition, this was merely designed in self-defence; and the growth of the Prussian monarchy continued in the main a legitimate internal developement.*

Lastly, the mighty struggles of Great Britain against Spain and France were undertaken for the extension of her colonial empire; and with the establishment of this—whether by morally justifiable means or not, it is beyond my present purpose to enquire,—within limits materially affected by the American War of Independence, the necessity or excuse for such wars has passed away for ever. There may seem a touch of hypocrisy in looking back with something like satisfaction upon a course of policy which most assuredly this country will never be willing to resume. But, historically speaking, this may be asserted: that the colonial wars of Great Britain were the results of causes not primarily connected with the principle of national self-preservation, which is involved in that of the

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* The secret, it may be said in passing, of the growth of the Prussian power most assuredly lies in the unabating devotion of its governments from that of Frederick II., or indeed from that of his father, downwards, to the perfection of their administrative system. As to the date when Prussia first became aware of her "mission," I most thoroughly agree with Mr. Bryce (see his masterly chapter "on the New German Empire," in the last edition of the *Holy Roman Empire*, p. 438), that "too much has perhaps been said of late years about" the mission in question. Indeed, the way in which this application of the historical "germ theory" has been preached has been far more edifying than convincing.

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balance of power, and that their issue in no wise materially affected the maintenance of the European system as one of allied independent States.*

At home in Europe Great Britain was true to the treaty which was the work of her own hand. One European Power only, as it could now be called,† preceded France in a scheme to unsettle the balance of Europe, or in other words to substitute a policy of forcible aggression—not less forcible because generally nicely timed—for one of deference to the system settled by the Utrecht Treaties and modifiable only by the whole body of European Powers adhering to them. But this Power contrived to make two others her accomplices in the conspiracy, and thus to shake the very foundations of European peace by destroying the elementary condition of mutual trust. The Partitions of Poland, of which Russia was the primary author, while they were shared with cynical greed by Prussia and with more or less dubious reluctance by Austria,‡ constituted

* Of the present and the future it may not be inapposite to say that colonial wars, involving the maintenance of the national honour, will continue to arise in unexpected quarters, and when once begun, will have to be fought out, in spite of protests sent in the rear of expeditions; but that a heavy responsibility will lie on the statesmanship of a country, which has beyond all doubt arrived at a point in her history when it behoves her to consider the objects, and, according to a definitely accepted view of them, to determine the limits of her colonial empire.

† Diplomatically speaking, Russia entered into the family of European States with the Treaty of Amsterdam (1717).

‡ Doubtless there was no hypocrisy in Maria Theresa's unwillingness. But her expression "J'ai toujours été contraire à cet unique partage, *si inégal*," characterises the real nature of Austria's "moral" scruples at what she had consented to. As for Prussian historians, they continue to regret the inevitable necessity of obtaining a reasonable north-eastern frontier.

the first open breach of the settled system of Europe by some of its great Powers,—a breach excused by no real need and defensible by no tenable argument. Nor were these Partitions sanctioned by any general European treaty, while Great Britain, thank God, undertook no engagement respecting them. This criminal violation of the fundamental principles of international law, identical with the eternal principles of morality, was to avenge itself upon two at least of its perpetrators. I am not aware of any more remarkable or instructive discovery—for it deserves the name —of the historic research of our own times than the proof which Sybel's masterpiece * has laid before the world, how the Partitions of Poland ripened the seeds of that bitter jealousy between Austria and Prussia which was a primary cause of the miserable collapse of the First Coalition against France.

The conclusion at which it thus seems justifiable to arrive is this: the causes of war are and ever have been many and varying,—at one time differences of religion have given rise to conflicts; at another, differences of nationality; now historical jealousies, now quarrels which seem to be thrown of a sudden between States like the apple of Eris. But for those wars which had their primary source in the growth of one Power into preponderance and aggressiveness, the system of the balance of power, in its more developed phase, furnished a remedy which made them less frequent, less protracted, less extended, and less uncertain in their issue than they would otherwise have

* The *History of the Period of the French Revolution.*

been. So far from being in themselves among the causes of wars, great international treaties, which, like those of Utrecht, are arrived at by the consent of the nations of Europe and guaranteed by their collective agreement, are in themselves securities, though not all-sufficient securities, of its Peace. They are unable to prevent wars arising on issues resulting from separate engagements or beyond the scope of their provisions, though even such wars they help to bring to a speedier conclusion. And the general security which they profess to give they are able to preserve, so long as the principle of a general adherence to them, and of a submission to modifications effected in them by common consent only, is itself maintained.

The Treaties of Vienna, which concluded the great Napoleonic war—the inheritor of the thoroughly aggressive character of the French Revolutionary war—differ in this respect from the Treaties of Utrecht, that they provided not a less, but a more explicit guarantee for the maintenance of the European system. Already at Vienna the most important questions were decided by a committee of the representatives of the Five Great Powers (while eight Powers generally undertook the settlement of territorial questions). But, which is of more signal importance, the alliance of the Five Great Powers * was henceforth established as a superintending authority over the international affairs of Europe. The Holy Alliance, whose ends have been frequently confounded with those of the Alliance of the Great Powers of the last Coalition, was nothing

* Originally of course of four; but France acceded at Aix-la-Chapelle, in 1818.

each Great Power was accordingly by no means to merge its own principles and ideas in those of the rest, but to labour at causing them to prevail by the means and on the occasions thus provided.

I do not assert that the system thus established was as adequately administered in the interests of national developement as in those of the maintenance of peace; but it must be allowed that with the sanction of this Alliance changes accomplished themselves in Europe consonant with the progress of national life and with the right of national self-determination. While much was left undone, much was done; and what was done was done permanently. The recognition of the independence of Greece, and of that of Belgium,* were thus guaranteed as international arrangements sanctioned by the public law of Europe. And of the Great Powers themselves, not one (though the will was not wanting) was able to pursue its designs of self-aggrandisement uncontrolled by the authority of a tribunal which it continued to acknowledge.

That this system, though still nominally in force, has been signally impaired in its efficiency, is not only due to the disturbing influences which have at various times operated, and are probably destined in an increased degree to operate, in the direction of change. It is also due to the growing tendency on the part of the Powers who still claim to hold the trust, to loosen their hands on the helm, and, instead of amending by

qui, dans chacune de ces époques, seront jugées les plus salutaires pour le repos et la prospérité des peuples, et pour le maintien de la paix de l'Europe." Sorel, p. 141.

* We recently indulged ourselves in the perfectly unnecessary luxury of renewing this guarantee.

joint agreement what is defective and ill agrees with the progress of the nations, to allow themselves or others to act independently of the common system of a guaranteed security which they still profess a desire to maintain.* Prussia began her great war upon Austria by formally putting herself in the wrong and cynically tearing up the Act of the Confederation to which she belonged, and the establishment of which formed an integral part of the Treaty of Vienna. Russia, acting on the Macchiavellian dictum that a wise prince keeps his engagements so long as it is neither in his power nor in his interest to break them, renounced another engagement contracted under the guarantee of the Great Powers; and though she afterwards acknowledged her dereliction of an established international principle, as her reward for the confession secured the object at issue.

The balance of power, we are told, has become an obsolete conception. In other words, a system making possible a combination in the interests of the general Peace of Europe against those who threaten to disturb it is no longer possible on the basis of settled treaties. Of the last war undertaken and ended in the spirit of that system no result

* It is perhaps needless to remark that guarantees which, like that inserted in the Luxemburg Treaty of 1867, are described as *solidaires* in the terms of the instrument, and subsequently explained to be *collective* only (as this was by one of the statesmen responsible for the Treaty itself, the present Foreign Secretary), are illusory and useless. Treaties of this kind accordingly reflect the reverse of credit on the statesmanship of their authors.

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remains "except a monument in Pall Mall in London, and the names of a bridge and a boulevard at Paris."* If this be the case, one of the methods which have served to diminish the chances of war and to facilitate the readjustment of peace being out of gear, it may be worth while to ask, in conclusion, whether there are any others which remain in force, or which may be looked forward to for the future? For that, if many causes of war have begun to disappear and others have decreased in activity, new causes have arisen and are arising around us in addition to the old which continue to exist, it is unfortunately only too easy to prove.† With the dreamers who imagine the reign of Peace at hand this enquiry has no concern; but it may be interesting to consider by what methods, apart from the discredited one which has been discussed in this Essay, it has been at various times, and is now, sought to meet the evil to which Europe, the chief bearer of Christian civilisation, has been and continues to be exposed.‡

Much of interest might be said, in connexion with this subject, with regard to the ideal Peace of the

* Laveleye, p. 252.

† This subject is treated with equal candour and ability by M. de Laveleye, whose work (quite apart from his view of the remedies applicable) accordingly deserves the attention of historical and political students alike. See also the case more briefly stated in his Cobden Club Essay (Second Series, 1871-2), *On the Causes of War and the means of Reducing their Number*, reprinted by the Peace Society.

‡ The best summary of the schemes which have been at various times formed for securing a general and perpetual peace, or for leading up to it, will be found in Wheaton's well-known *History of the Law of Nations*. I have, where possible, consulted original sources; but my obligation to Wheaton of course remains.

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circumstance that its realisation, like that of the excellent General Garibaldi's plan of Perpetual Peace, would have necessitated a good final war to begin with. But *not*, as seems now historically ascertained, in any sense Henry IV.'s plan as a definite scheme; not even proved to have been his councillor Sully's plan as a settled proposal; probably only an ingenious day-dream, of which not even the practical preliminary clause—the reduction of the power of the House of Habsburg—consistently formed a distinct element in Henry IV.'s actual policy. A piece of paper which, like the maps we used to see in Paris shop-windows under a late *régime*, might, had it suited an ulterior developement of Henry's policy to set the whole of Europe aflame, have contributed to ignite parts of the congeries into which it proposed to introduce so lucid an order. But so vast in its dimensions, and so impossible in its benevolence, that it might well serve to give a comparatively practical aspect to the proposals for the Peace of Europe which were to succeed it.

Thus, in 1693, in his *Essay on the Present and Future Peace of Europe*, William Penn, in urging the plan of a general congress for the settlement of inter-

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council of sixty deputies to manage common affairs; six divisional councillors, those of the several groups of the European system of States." Mr. Motley, in his *Life of John of Barneveld* (vol. i. p. 229), though he aptly says of this plan, "Nothing could be more humane, more majestic, more elaborate, more utterly preposterous," seems to treat it as a real scheme of Henry IV.'s, cut short by the "broken table knife sharpened on a carriage-wheel" of Ravaillac. Elsewhere (p. 187) he has himself given an instance of the untrustworthiness of Sully's *Memoirs*.

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national disputes, refers to the "great design of Henry IV." as an example that what he proposes "is fit to be done."* More venturously the Abbé de St. Pierre, inspired with disgust by the difficulties which he had witnessed at the Conferences of Utrecht, clothed his proposals for a Perpetual Peace in the pseudo-historical garb of a Project composed by Henry IV. and Sully themselves. His scheme is in a word that of an arbitrarily-arranged federation between the principal European States, to which tribunal all differences between the members of the Federation are to be referred, three-fourths of the votes being necessary for a final judgment, and the power of the whole Alliance being bound to support its decisions.† This scheme was subsequently reproduced in a lucid

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* "His example tells us that *this is fit to be done.* Sir Wm. Temple's '*History of the United Provinces*' shows us by a surpassing instance that *it may be done;* and Europe, by her incomparable miseries, that *it ought to be done.*" After searching Temple's tomes in order to satisfy myself as to the precise meaning of the second reference, I cannot but suppose that it is to the passage in chap. viii. extolling the Triple Alliance (to which Bentham,too, refers in his Essay noted below) as the cause of the peace of Aix-la-Chapelle. "Thus all Europe," says Hume (chap. lxiv.), "seemed to repose herself with security under the wings of that powerful confederacy which had been so happily formed for her protection." There is, however, of course no real analogy between the action of the Triple Alliance and that of such a federation as the one sketched in the supposed scheme of Henry IV.

† Wheaton, pp. 261-3, and cf. the *Extrait* and *Jugement* in Rousseau, *Œuvres*, vol. v. (1832); for Wheaton has perhaps not quite seized the character of Rousseau's criticisms. Of St. Pierre's scheme the peace-loving French Minister Cardinal Fleury ("peace is my delight," says Pope, "not Fleury's more") remarked that it omitted an essential article, viz., one providing for the sending forth of missionaries "pour toucher les cœurs des princes et leur persuader

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Summary or *Extract*, by J. J. Rousseau, to which he added a *Judgment* or criticism, written in a vein of admirable irony, of his own. His objection to the plan is that any attempt to execute it would meet with violent resistance from the princes, whose view of their own interests is opposed to those of the peoples, and from the ministers, whose interests are always antagonistic to those of the peoples, and almost always to those of the princes as well. He was therefore little edified by the worthy Abbé's argument * that it was only necessary for the princes to be brought to a better intelligence of their own true interests, and the rest would easily follow. The difficulty, no doubt, lies in the indispensable preliminary. So I find that it has been remarked by Earl Russell,† with a cautiousness which has at times not been considered his most pre-eminent characteristic, that, "on looking at all the wars which have been carried on during the last century, and examining into the causes of them, I do not see one of these wars in which, *if there had been proper temper*

d'entrer dans vos vues." The hint was taken by the famous deputation which waited on the Emperor Nicholas in 1854, instead of the advice which to philanthropic dogmatism will always seem feeble time-serving, but which proceeded from no time-serving and no feeble lips: "And to be plaine with you, truelye I can not allowe that such communication shalbe used, or suche counsell geuen, as you be suere shall neuer be regarded nor receaued. For howe can so straunge informations be profitable, or how can they be beaten into their headdes, whose myndes be allredye prevented: with cleane contrarye persuasions? This schole philosophie is not unpleasaunte amonge frendes in familiare communication, but in the counselles of kinges, where greate matters be debated and reasoned with greate authoritye, these thinges have no place." More's *Utopia*, Bk. I.

* *Extrait*, p. 40.

† Quoted in one of the Peace Society's fly-sheets.

between the parties, the questions in dispute might not have been settled without recourse to arms." If there had been proper temper between the parties.

It is, by the way, noteworthy that these early literary schemes of universal peace seem, as a rule, to have been generally more immediately suggested by some external event appearing to point in the direction of their objects, but really of a very different character. So that, if I may use so irreverent an expression of the utterances of philosophers, they wear the appearance of happy thoughts, or at least of incidental dialectical exercitations, rather than of the condensed results of political experience or historical study. Thus, if St. Pierre's Project followed upon the Peace of Utrecht, which achieved its limited ends by limiting its means, the next project (Bentham's) was obviously a consequence of the Armed Neutrality of 1780, the results of which were so insignificant that Catharine of Russia, who had been led to become its authoress, afterwards called it the Armed Nullity.* Finally, Kant's project, to be noticed below, was doubtless, in the first instance, suggested by the Peace of Bâle and the attempted guarantee of the neutrality of the North German States in 1795, which transactions it is to be hoped require no characterisation.† I am, of course, well aware at the same time that Bentham's project

* Dyer's *Modern Europe*, iii. 534.

† For how was this guarantee to be secured? See the *Secret* Article (1): "Dans le cas que le gouvernement d'Hanovre se refusât à la neutralité, S. M. le Roi de Prusse s'engage à prendre l'Électorat d'Hanovre en dépôt, afin de garantir d'autant plus efficacement la république française de toute entreprise hostile de la part de ce gouvernement." Häusser, *Deutsche Geschichte*, &c., i. 596, *note*.

was thoroughly consonant with the whole tenour of his political philosophy, and that Kant afterwards again insisted upon his views in an important work.*

Bentham's project † was composed not long before the beginning of that long series of aggressive wars which unhinged the political system of Europe; but it would be foolish to attach too much importance to the moral which this circumstance conveys. For the really practicable part, and at the same time the essential feature, of his scheme is tentative; it connects itself with precedents of a similar scope though on a smaller scale; and being intended to operate by purely moral means, can of course be only expected to operate gradually. Elsewhere Bentham had defined the objects of an international code which should regulate the conduct of nations in their mutual intercourse; he here suggested the establishment of a common court of judicature for the decision of international differences; arguing that although such court were not to be armed with any coercive powers, its salutary influence would consist in its reporting its opinion and causing that opinion to be circulated in the dominions of each State. Wheaton observes on the difficulty which would arise of preventing the more powerful members of such a league from acquiring absolute control over it; but this would constitute no insuperable difficulty were the constitution of the league made the subject of careful international agreement. But the idea is one the exe-

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* Viz., the *Metaphysics of Jurisprudence*, published in 1797.

† It will be found in vol. ii. of Bowring's edition of the *Works*. According to Wheaton, it was to form part of an essay on International Law, which remained in a fragmentary state.

cution of which would require a long series of preparatory steps, lest the attempt to codify much that is virtually settled, together with what is still unsettled, should lead to the creation of difficulties by means of the very endeavour towards uniformity.

A more fatal criticism on the plan, as corresponding to the end for which Bentham proposes it, seems to me to lie in the fact that nations by no means always, or even generally, make war because of the questions on which they profess to make it. A tribunal, however constituted, could hardly have settled the Schelde difficulty in 1792, or the Hohenzollern difficulty in 1870, except in one way; but how could it have weighed in its scales the motives which really hurried France into war in either case?

On the other hand, the proposals by which Bentham sought to facilitate the success of his plan, or to supplement its operation as obviously in itself inadequate, are really beyond the sphere of permanent international agreement. These were the "fixation" of the armed forces of the several European States, and the emancipation of the distant dependencies or colonies of those possessing any. Into his arguments against the utility of colonies I cannot here enter; but it seems clear that neither in this respect nor in the matter of disarmament can any State allow measures affecting the question of its own safety—the supreme end of its existence as a State—to be permanently fixed by international agreement. The impossibility of any such settlement is best shown when Bentham approaches a practical suggestion, and throws out the hint that Great Britain "might perhaps allow to France and Spain and Holland, as

making together a counterpoise to her own power, a united naval force equal to half or more than her own." All such proposals for partial disarmament are opposed to the principle which Hegel justly asserts, that there is no supreme judge between States except where special agreements have constituted one (how then could the scale of disarmament be preliminarily fixed?), or except where the spirit ruling the world has imposed its binding laws upon the universe. In other words, the preliminary measures indispensable to the success of Bentham's scheme (except as a tentative and gradual progress towards the establishment of an international code administered by an international tribunal exercising a moral influence only) are to be expected from a growth of sentiment which time alone can ripen, and from this alone.*

Finally, I may confine myself to the briefest possible notice of the last of these earlier literary projects of perpetual peace, that published by Kant in 1795, and republished with an addition in 1796.† And this with the less danger of doing it an injustice, because (as it seems to

* A fuller discussion of Bentham's project would of course necessitate an enquiry into the whole conception of the State which it implies. I may add that the necessity of revising the conception of the rights of individual States on which the European system is based is urged in an ingenious essay in which Professor Seeley adds another scheme to those discussed in my text. See *The United States of Europe*, *Macmillan's Magazine*, vol. xxiii. (1871).

† It is printed in the latter form in Rosenkranz and Schubert's edition of Kant's *Sämmtliche Werke*, vol. vii., and will of course not be confounded with a paper in vol. i., which may strike some minds as equally Utopian, viz., the *Verkündigung des nahen Abschlusses eines Tractates zum ewigen Frieden in der Philosophie* (1796). The first edition of the essay adverted to in the text was bought up in a few weeks.

me), notwithstanding the touches of feeling and humour and even political shrewdness * which this treatise ex-

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* Though in the half-humorous preface to the *Project*, Kant expressly asks from the practical statesman, in compensation for the contempt which he will inevitably display for the lucubrations of the theoretical politician, a belief that if the latter can do no good, at least he means no harm, it is well known that he took a keen interest in politics. And this, though in its external circumstances his life resembled that of Claudian's "senex Veronensis, qui suburbium nunquam egressus est" (see Cowley's Essay, *The Dangers of an Honest Man in much Company*). The project is divided most diplomatically into Preliminary Articles and Definite Articles, with a Guarantee and a Secret Article (the latter, if I remember right, added in the second edition). The preliminary articles assert that no peace is to be accounted such which secretly retains the materials for a future war. No independently existing State is to be permitted to be acquired by inheritance, exchange, purchase, or donation. (For, as Kant explains, "it is not usually known that at the present day States can marry one another." Yet the philosopher's net has a gap; he has left out, as indeed he could not foresee, plebiscites.) Standing armies are in course of time to cease altogether; but not defensive systems of civic exercise in arms. No debts of State are to be contracted with reference to external quarrels. (The "commercial people" to which Kant makes pointed reference has certainly since his time increased its experience of the truth that the practice of making posterity pay for wars constitutes an obstacle to eternal peace.) No State is to intervene by force in the constitution or government of any other. Finally, in war no State is to omit the observation of duties the neglect of which would render mutual confidence in future times of peace impossible. The definitive articles are based on the principle that peace is not the natural condition of man. From this it follows that a perpetual peace must be established on artificial bases. These are furnished by three articles: (1) The civil constitution in every State shall be one which separates the executive power from the legislative. (2) International law is based upon a federation of free States. (3) The civic franchise of members of the general community of the world is to be confined to conditions of universal hospitality. The guarantee of a perpetual peace is furnished by Nature, with whose ends it is in manifest consonance; and to avoid mistakes or hasty measures, a secret article is to be added, according to which the maxims of philosophers as to the

hibits, its highest value lies in that section where it reverts from the question of the application of principles to the consideration of general principles themselves. The great error in the scheme itself was, I think, justly pointed out by Hegel, who argued on the principle which is in truth the cardinal axiom of the modern system of State-government, that States, as individuals, cannot be deprived of the right of negation. From this it follows that nothing but the adherence of each contracting party to its own engagements can actually secure pacific conduct on its part. To multiply these engagements, and to extend them from the acceptance of facts to the recognition of principles of international law, is therefore the surest way of diminishing the chances of war. The right of negation is limited, says Hegel, by specific agreements and by generally accepted moral principles. The result which the statesmanship of Europe, proceeding on this basis, may secure in the future, more fully than it was secured by the limited system of the balance of power directed to limited objects in the past, will be the opposite of the result established by Spinoza, who, true to his principle that the natural state of man is a state of war, held that no nation is bound to observe a treaty longer than the interest or danger which caused that treaty continues.*

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possibility of public peace are to be consulted by those States which are armed for war. In the *Appendix*, in which, as said in the text, I venture to think the chief value of this essay lies, Kant demonstrates with convincing lucidity the objective identity between the true principles of ethics and those of politics.

* For Hegel's argument, taken from his *Grundlinien der Philosophie des Rechts*, see Wheaton, pp. 754-8. His cardinal maxim has

It is well known that, apart from the project of the Holy Alliance, to which I need not again refer, our own century has witnessed many efforts in the same direction as that in which the projects enumerated above pointed. These efforts were primarily due to the reaction brought about by the awful struggle against Napoleon, which raised in many benevolent minds the wish that the gates of Janus—whose temple the conqueror had not found time to erect, as he had proposed, on the heights of Montmartre—might be closed for ever. The London Peace Society was founded in 1816; many similar societies were soon established on the continent of Europe and in America. In 1848 a general congress of representatives of these associations was held at Brussels, where the necessity was urged upon the several Governments of Europe and America of introducing into all international treaties an arbitration clause, by the application of which war would be avoided in the settlement of disputes.

I unwillingly pass by the efforts made on the other side of the Atlantic in furtherance of such views as these. They had indeed a much earlier beginning than the American Peace Society; for when, in 1825, the Panama Congress scheme (which proved abortive) was debated at Washington, President Adams could recall the attempts made by Congress after the War of Inde-

been recently repeated in a speech as thoughtful in conception as it is firm in tone—the significance of which is by no means limited to its bearing on the question immediately at issue—that of Count Moltke in the Debate on the New German Army Law, Feb. 16th, 1874. Nor is it too much to say that the political mind of Germany is at present concentrating itself on the realisation of that idea of the State of which political speculation elsewhere is suggesting the abandonment.

pendence, of which one at least had resulted in the conclusion of a treaty of amity, navigation, and commerce (with Prussia). Nor should it be forgotten that the principles which American diplomacy has stedfastly upheld, and caused in part to be accepted by other maritime nations, were here for the first time established as bases of an international agreement. Encouraged by the sanction of the views of the Peace Society on the part of a State Legislature (that of Massachusetts in 1835), the Committee of the United States Senate on Foreign Relations, in 1851, recommended the adoption of an arbitration clause in every American treaty where possible; and the same recommendation was repeated by the same authority in 1853. It is at the same time true that a clause of this description was *not* inserted in the treaty concluded between ourselves and the United States at that very time, though approved, as it is stated, by the British Minister.*

In Europe isolated attempts have likewise been made to procure for the principle of arbitration as a regular expedient for the settlement of international difficulties the sanction of Parliamentary declarations (as an occasional expedient it has, of course, been frequently resorted to, but of this immediately). In the year 1849 the Committee of Foreign Affairs of the French National Assembly rejected a recommenda-

* So I have read that Vattel states how the provision for arbitration in all treaties concluded by the Helvetic Republic is a wise precaution, which has not a little contributed to maintain that Federation in the flourishing condition which secures its liberty, and renders it respected throughout Europe, and yet that he likewise observes how the Swiss, on occasions when their liberty was menaced, have refused to submit their disputes to arbitration.

tion that the French Government should propose to the other Governments of Europe and America to unite by their representatives in a congress which should substitute an arbitral jurisdiction for the barbarous usages of war. In the same year, and again in 1873, the subject was brought before the British House of Commons. Between Mr. Cobden's motion and that of Mr. Henry Richard there are however several points of difference. Mr. Cobden asked that our Government should put itself into communication with the Foreign Powers separately, inviting them to enter into treaties binding the respective parties, in the event of any future misunderstanding which could not be arranged by amicable negotiations, to refer the matter in dispute to the decision of arbitrators. Mr. Richard proposed that our Government should endeavour to bring about, together with a general improvement in international law, the establishment of a general and permanent system of International Arbitration.*

It is within recent memory that the latter of these motions, though opposed by the Government, was accepted by a majority of the House of Commons; that a Royal message subsequently promised the communication, at a suitable time, of the views thus sanctioned to Foreign Powers; that the author of the Resolution has since received the congratulations, and by his personal efforts stimulated the activity, of those who share

* It may also be noted that while Mr. Cobden thought that the arbitrators had better be private persons, qualified by their special attainments for the decision of particular questions, Mr. Richard seems to have left the institution of the court of arbitrators an open question, but apparently designed it to be composed of persons of an official character.

his views abroad, and that the Italian Chamber has unanimously adopted a motion (proposed by Dr. Mancini) in the sense of that which had previously passed the British House of Commons.*

Reference was made in the debate of 1873 to a step in the direction of the motion which had on a previous occasion been actually taken by the British Government. But on a perusal of the records of the Paris Conference of 1856, it becomes obvious how far the principle there adopted falls short of that sanctioned by the House of Commons (and apparently by the Italian Chamber) in 1873. At the Conference held to settle the terms of the peace concluding the Russian War, Lord Clarendon reminded the Plenipotentiaries that a stipulation already inserted in the Treaty (which bound the Sublime Porte, in the event of any difference with any of the other Powers, to enable the Parties to the Treaty to attempt mediation before war was resorted to) might well receive a more general application, and thus become a barrier against conflicts arising out of unexplained misunderstandings. He accordingly proposed a resolution in this sense, which should not however trench upon the independence of the several Governments. In the discussion which followed,† the proposal of Lord Clarendon was ultimately accepted, but in a modified form, completely safeguarding the independent rights of the Powers, and in point of fact

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* The precise terms of the Italian resolution or resolutions have not reached me.

† It was enlivened by a characteristic passage at arms between the Austrian representative, Count Buol, and Count Cavour, with reference to the application of the principle to *de facto* governments.

merely affirming the wish of the Conference that the mediation of a friendly Power might be sought, so far as circumstances permitted, before war was resorted to, and its hope that the Governments not represented at the Conference would join in the idea which had suggested the wish.* The modest recommendation actually protocolled it has once been sought to apply—before the Franco-German War of 1870, with what result is known.†

Now, with regard to these efforts, it will be observed

* "Messieurs les plénipotentiaires n'hésitent pas à exprimer, au nom de leurs gouvernements, le vœu que les États entre lesquels s'élèverait un dissentiment sérieux, avant d'en appeler aux armes, eussent recours, en tant que les circonstances l'admettraient, aux bons offices d'une puissance amie.

"Messieurs les plénipotentiaires espèrent que les gouvernements non-représentés au Congrès s'associeront à la pensée qui a inspiré le vœu consigné au présent protocole." But the plenipotentiaries also—

"Conviennent que le désir exprimé par le Congrès n'entraverait en rien la libre appréciation dans les questions qui touchent à sa dignité, qu'aucune puissance ne saurait abandonner." *Laveleye*, p. 270.

† There was a rumour, as to the truth of which I am ignorant, of the attempt having been repeated on the occurrence of the recent *Virginius* difficulty—a difficulty which is stated to have been described by an American authority on international law (Dr. Woolsey, of Yale) as "an extreme case, which the ordinary law of nations does not meet." The use of arbitration has been suggested in a still more recent instance; for I observe that the 'Midland International Arbitration Union' urged the expediency of settling our difficulty with the Ashantee people "by negotiation, and, if expedient, by arbitration of some friendly potentate, such as the King of Holland." A Cabinet Minister (Mr. Bright) stated that he was "glad to hear" of this resolution. See *The Times*, Jan. 15, 1874. Other means have been preferred, and the gallant officer who has carried the Ashantee war to a successful issue has publicly congratulated himself on having been encumbered in his proceedings by no diplomatic interference.

that they are partly directed to the extension of the use of a political expedient long familiar to diplomacy, partly designed to bring about what the world has not yet seen, an International Code administered by an International Tribunal. The realisation of this latter end would either involve or supersede—according to the constitution of the tribunal—a general adoption of the method of arbitration.

The principle of arbitration itself has frequently been put in force in the diplomatic history of the present century. Already the peace which put an end to the War of American Independence was supplemented by a treaty (in 1794) providing for the settlement of a boundary difficulty by a commission of arbitrators. Disputes as to claims for losses in war between the United States and France, Spain, Great Britain, and Mexico severally, between Great Britain and France (in the case of the Portendie claims), boundary disputes between the United States and ourselves, and similar difficulties have been settled by jointly-appointed arbitrators, or arbitratory commissions of various descriptions.* The usefulness of the method is therefore incontestable, and so far as it acts as a preventive of causes which might be made the pretexts of wars, it has operated in favour of peace. On the other hand, it must be confessed (I speak with such knowledge as I possess of the dis-

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* See Laveleye, Part. Ire. chap. vii. : "La Haute Cour Arbitrale est préparée par l'Arbitrage." See also *A Historical Survey of International Arbitration*, reprinted from the *North American Review* for the London Peace Society. The San Juan difficulty, settled by the arbitration of the Emperor of Germany, belongs to this category of cases.

putes and difficulties in question) that there was in the case of none of these difficulties any immediate or serious prospect of war in the case of their non-settlement.

The defence of the recent settlement of the so-called "Alabama Claims," on the other hand, of which settlement I do not hesitate to assert that most Englishmen are in their hearts ashamed, lies in the assumption that a real danger of war was thereby averted, as well as the probability of future war diminished. When it shall have been proved that the danger in question actually existed in any serious degree, and when it shall have become manifest that the temper towards one another of the two nations involved has been seriously modified by Great Britain's concessions, the view in question will be accepted by historical students as it has been proclaimed by politicians.

The attempt to induce the other Great Powers to accept the rules agreed upon at Washington between our Government and that of the United States, and acted upon at Geneva, has for the present been postponed; and it was at least a novel conception of diplomatic action that independent Powers should be invited to subscribe to principles adopted without consultation with them. The entire negotiation has, therefore, not as yet resulted in any general international agreement of the description aimed at by those who applaud it as a hopeful step in the desired direction.

Meanwhile, the fact remains that there is no "great question of the last few years on which a suggestion of arbitration would have been listened to for a moment,

except the question of the *Alabama*,* the settlement of which certainly had very peculiar features of its own. The *Virginius* difficulty has been settled in a different way by one of the very Powers which were parties to the Treaty of Washington. Of the great questions which agitate Europe no Government dreams of referring any one to a settlement by this method.

While, therefore, the results of a historical survey induce us confidently to expect that the practice of referring to arbitration questions of the character of those which it has proved able to settle, will probably be resorted to with increasing frequency, it would be more than rash to infer from this probability the other, that the method of arbitration will be resorted to in order to settle questions of primary importance, or to avert immediately impending wars. Least of all is it possible to regard arbitration as an expedient capable of a forced universal application; for, in the words of an eminent writer of practical experience, "arbitration must of necessity be voluntary; and, though it may sometimes be a moral duty to resort to it, cannot be

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* See an article in the *Saturday Review*, Dec. 27, 1873, entitled "The Apostle of Arbitration." The tone of this article may not be pleasant,—but can any answer be given to it? To what does the address of the committee of the Peace Society to the "friends of peace," issued in September 1873, amount, except to a confession that with the exception of resolutions and congratulatory addresses nothing has been effected? With regard to the questions of the present, it is difficult not to subscribe to the view expressed in an article in the same journal, Nov. 29, 1873: "When Russia, the United States, and Italy, are respectively prepared to submit or refer to arbitration the occupation of Khiva, the Santiago outrage, and the possession of Rome, the vote of the Italian assembly will deserve a certain amount of practical respect."

commanded in any form by what is called the positive law of nations." *

Of a far more speculative character is the question as to the results which may be looked for from the formation of an International Code, administered by a permanent International Tribunal. An International Code, at least as partially accomplished, must be the indispensable antecedent of the tribunal which is to administer it. Grave doubts are, however, entertained not only as to the possibility of the formation of such a code, but as to its desirability. It is open to question whether the reduction to settled forms of all the principles which at present regulate the conduct of nations towards one another might not prove a source of difficulties rather than an expedient for obviating them. In any case, the undertaking is one of exceeding magnitude, and must occupy a long time. On the other hand, the assimilation of usages affecting the international relations among different States, the removal of discrepancies in the conception of inter-

* See a letter to *The Times*, Oct. 18, 1873, from the Right Hon. Mountague Bernard. It is difficult to understand why, holding such views, Prof. Bernard should have consented to the word *obligatory* in the following resolution accepted by the Conference for the Reform and Codification of the Law of Nations at Brussels on October 13th: "That this Conference declares that it regards arbitration as a means essentially just and reasonable, and even *obligatory* on all nations of terminating international differences which cannot be settled by negotiation. It abstains from affirming that in all cases, without exemption, this mode of solution is applicable, but it believes that the exceptions are rare, and it is convinced that no difference ought to be considered insoluble until after a clear statement of complaints and reasonable delay, and the exhaustion of all pacific methods of accommodation."

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national obligations as expressed in the provisions of municipal law, and in particular cases the acceptance by means of treaties of principles of international law as binding, are objects which should engage the constant attention of political activity. Every step in advance is here of high value; and (which is of the utmost importance) steps in this direction have been already taken.* It is the business of jurists and publicists to prepare public opinion in different countries for the acceptance of views to be in due course adopted and urged by the Governments. Association—the great moral engine, for good as for evil, of our age—will of course promote with its mighty power the endeavours of individual effort.† Though these endeavours must, if they are to retain the scientific character which alone will entitle them to become the basis of accepted principles, remain independent of Government support, it cannot be considered unduly sanguine to look for an increase of diplomatic action in the direction of bringing about the acceptance by Governments of principles commended by the gradual determination of instructed

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* Thus principles of international maritime law have already been accepted as binding by at least six States; and if the United States have not accepted them, it is only because they desire to see another added.

† I have no space to attempt an estimate of the proceedings of the Brussels Conference adverted to above. But whatever criticisms might be justified by the ambitious title of "the Association for the Reform and Codification of the Laws of Nations" there established, no exception can be taken to such a foundation as that of the *Institut de droit international*, established at Ghent in the previous month. This society (among whose original members are Professor Bluntschli and M. de Laveleye) appears to be founding branch associations, an account of one of which has reached me from Bremen.

public opinion in their favour.* When there are no principles or usages of importance left on which any divergence remains between the practice of the more important Governments, it may become time to take into consideration the possibility of the establishment of a permanent judicial commission to determine their application in particular cases as they arise. Lastly, as experience shows the cases to have been extremely rare in which arbitral decisions have been rejected by the parties, it may be that a similar influence would attach to the decisions of such a tribunal when permanently established. In any case the choice between a decision of arbiters without reasons assigned and a decision of arbiters on principles adopted in order to constitute a clear offence against international law would then no longer offer itself as the only method of avoiding an appeal to arms. Thus it is highly probable that a considerable number of possible causes of war would be prevented; and it would depend on the respect which the working of the court had acquired whether the body of States which had agreed to the code would combine to enforce its decisions. But this is only the last step in a progress to be ultimately hoped for,—a step so remote that any discussion of its practicability is at present a mere waste of words.

But, to conclude. Suppose this path to be steadily followed; suppose the concomitant operation of other international treaties, such as that of the blessed Geneva Conference as to the treatment of the sick

* Thus, *e.g.*, as to the question of the supply of arms by neutrals.

and wounded in war,—a leaf of real beneficence from Kant's visionary essay; suppose the increase of postal, monetal, and well-devised (not ill-devised and retrograde) commercial treaties between nations which are from day to day growing more dependent upon one another for the very necessaries of their existence.* Suppose all this; and yet only the dreamer will conclude that the Peace of Europe, or—if the expression be preferred—the peace of the world, will be assured by such means. And for this reason: that these means only direct themselves to the removal or prevention of some among the causes of war. Others among these they can only partially affect; and there are still others which it is to be feared they hardly touch. The natural combativeness of man, the spirit of conquest, illegitimate ambition, desire for aggrandisement pure and simple—where is the remedy for these to be sought unless in the progress of individual and, in time, of national enlightenment? And again, as to other causes of war, on which I have left myself no space even barely to touch. To the operation of historical—of hereditary—jealousy can be opposed nothing but the gradual discernment of common interests, and also, let it be hoped, of common ties, with which the markets have no concern. The intervention of States in the internal affairs of other nations is becoming a thing of the past, as nations recognise more surely the conditions of their own prosperity, and devote themselves with a clearer consciousness to the duties of

* See this subject, which has a most important bearing upon the whole question, most ably argued in Mr. F. Seebohm's book *On International Reform* (1871).

their own developement. Lewis XIV., of whom so much was said in an earlier part of this Essay, would not have set Europe in flames had he endeavoured to meet the progress of decay in France itself. The conflict of nationalities and the struggle between entire races on the other hand may seem to be in a phase of intensification; but here again nothing can operate more potently for the preservation of peace than the advance of instruction, which while it strengthens the ties of national life reveals the inadequacy of mere ties of position, descent, or speech in themselves. Fantastic notions as to the paramount significance of mere linguistic or even ethnographical unity will vanish before the progress of Science, which by exhibiting the variety of such distinctions establishes the consequent absurdity of regarding any of them as absolute. A nationality is made a nation not by geographical situation only, not by a common language only, not by a common descent only: but by a common history. Least of all will the war of classes—the new and most dire international danger of Europe be effectively prevented by any other means than the spread of the truth that classes, like nations, are interdependent, and that the noble ends of life which education alone reveals are common to all.

And thus an enquiry which has necessarily taken a wide range brings me very near home at its close. My object has been to show how, during nearly the whole of the eighteenth century, the European system was, though imperfectly, yet in the main really as well as nominally, secured by a system of general treaties;

that in the present century the more special and precise adjustment of this system served its limited end so long as the duties undertaken by the representative Powers were by them conscientiously performed. Lastly, that this basis of security having been if not nominally removed, yet at least signally impaired, the remedy for the danger accruing with new force to the Peace of Europe is to be sought, not in an abandonment of the principle of joint action, but in an enlargement and elevation of it, and in the progress of that enlightenment which, instead of enfeebling, strengthens the common action of men and of States. For it is with nations as with individuals. The cultivated and by culture enlightened mind is and must be on the side of progress and peace against that of darkness and conflict. The obscure men, like the unformed nationalities, are at once materials and causes of that which disturbs, unsettles, and retards personal and national and international life. Where the education, and more especially the higher education, of a country is fostered, there lie the best promises of progress and of peace.

It is for this reason that I have not thought the subject of this Essay out of harmony with the spirit to which all the contributions to this Volume are intended to bear witness. In this spirit the College was founded in whose career it has been our purpose to commemorate an event significant of endeavours of the past and of hopes for the future; in this spirit it has overcome the difficulties of its earlier days; in this spirit it has, in its new

home, begun a second period of united effort. May the noble words of the Elizabethan poet prove true both of it and of the great cause to which it is consecrate:—

> "The mortar of these walls, temper'd in peace,
> Yet makes the building sure."

A. W. WARD.

THE END.

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